

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS.,
Petitioner,

v.

CORRIGENT CORPORATION,
Patent Owner.

Case IPR2023-00447

Patent 9,118,602

DECLARATION OF GEORGE N. ROUSKAS, PH.D.

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I, George N. Rouskas, Ph.D., hereby declare as follows:

I. Introduction

1. The facts set forth below are known to me personally, and I have firsthand knowledge of them.

2. I make this Declaration in support of the Patent Owner's Response to the Petition for *inter partes* review ("IPR") of U.S. Patent No. 9,118,602 ("the '602 patent") (Ex. 1001).

3. I have been retained by Steptoe & Johnson LLP on behalf of the Patent Owner, Corrigent Corporation ("Patent Owner" or "Corrigent").

4. I am being compensated for my professional consulting services in connection with this matter. My compensation is not dependent in any way on the contents of this Declaration, any further opinions or testimony I may provide, or on the outcome of this matter.

II. Qualifications

5. A summary of my qualifications is provided below and a complete identification of my qualifications is provided in my current curriculum vitae, which is attached hereto as Appendix A.

6. I am an expert in network communication systems and especially packet-switched network communication systems and the various fields therein, including Multi-Protocol Label Switching (MPLS) networks, link aggregation such

as with a Link Aggregation Group (LAG), and processing and transmission of packets within and between network devices such as routers and switches. I have been an expert in this area since prior to 1992. I have relied upon my training, knowledge, and experience in the relevant art to form my opinions in this matter.

7. I am an Alumni Distinguished Graduate Professor with Tenure in the Department of Computer Science at North Carolina State University (NC State), where I also serve as the Director of Graduate Programs. I am an experienced researcher and educator in the area of computer networking, with expertise in Internet architectures and protocols, Telecommunications, MPLS networks, network devices including routers, switches, gateways and servers, network topologies, network performance evaluation, routing and load balancing, network measurements, network and traffic engineering, and network design, provisioning, and optimization.

8. I have thirty-four years of experience in computer networking since I received my bachelor's degree in 1989. I have twenty-nine years of experience as a professor in the Department of Computer Science of NC State.

9. I have taught courses on computer networks, Internet protocols, data structures, computer performance evaluation, and queueing theory. In 1997, I created one of the world's first graduate level courses on Internet Protocols, which I continue to teach regularly, and in which I cover in depth topics related to TCP/IP

networking, including routing and switching, MPLS networks and label switching, client-server applications, load balancing and quality of service, and layer-2 protocols including Ethernet and link aggregation. In 2001 I developed an advanced graduate level course on optical networks in which, among other topics, I cover optical transport networks (OTN), SONET and RPR, wavelength (optical label) switching, and protection. Since 1994, I have taught a graduate level course in computer performance evaluation where I cover the application of simulation and queueing theory to evaluating the performance of computer networks with respect to throughput and response time.

10. In my career in this area, I have received numerous accolades for my contributions to computer networking, including being elected as Fellow of the IEEE in 2012. Other accolades include the Outstanding Service Award for the Optical Networking Technical Committee (ONTC) of the IEEE Communication Society (2019); the Joyce Hatch Service Award from the NC State Chapter of the Association for Computing Machinery/Association of Information Technology Professionals (ACM/AITP) (2018); the title of Distinguished Lecturer in the IEEE (2010-2012); an IBM Faculty Award (2007); the Best Paper Award for the International Workshop on End-to-End Virtualization and Grid Management (EVGM) (2007) (with C. Castillo and K. Harfoush); the Best Paper Award for the International Symposium on Communication Systems, Networks and Digital

Signal Processing (CSNDSP) (2006) (with B. Chen and R. Dutta); the ALCOA Foundation Engineering Research Achievement Award, NC State College of Engineering (2004); the Alumni Outstanding Research Award, NC State (2003); the CAREER Award from the National Science Foundation (1997); and the Graduate Research Award from the Georgia Tech College of Computing (1994).

11. I received my Ph.D. in Computer Science (Georgia Institute of Technology, 1994); M.S. in Computer Science (Georgia Institute of Technology, 1991); and B.S. in Computer Engineering (National Technical University of Athens, 1989).

12. In 2000-2001, while on Sabbatical from NC State, I worked as Network Architect for Vitesse Semiconductor, where I was responsible for the design of a then state-of-the-art 2.5 Gbps network processor for ATM networks.

13. My work as an academic began in 1994, when I joined NC State as an Assistant Professor. In 1999, I was promoted to Associate Professor with Tenure. In 2002, I was promoted to the position of Professor.

14. I have held visiting positions on the faculties of a number of international universities, including positions as a Distinguished Scientist at King Abdulaziz University (Saudi Arabia, 2013-2021); Visiting Professor at the Laboratoire d'Informatique University of Paris 6 (France, October 2012); Visiting Professor at the Universidad Tecnica Federico Santa Maria (Chile, December

2008); and Visiting Professor at the Laboratoire de Méthodes Informatiques University of Evry (France, July 2006, December 2002, June 2000).

15. I have received funding from numerous agencies, foundations, and companies for research on network design and optimization. The sources of funding for this research include the National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), the National Security Agency (NSA), Microsoft, IBM and Cisco.

16. I have served in a number of leadership roles for the IEEE, including as Chair of the IEEE Communications Society's Distinguished Lecturer Selection Committee (2016-2017); Vice Chair of the IEEE Communications Society's Technical and Educational Activities Council (2016-2017); and Chair of the IEEE Communications Society's Optical Networking Technical Committee (2016-2017).

17. I have served in various founding, editorial and leadership positions for publications in my area of expertise, including as founding Editor-in-Chief of IEEE Networking Letters (2018-2021); founding Editor-in-Chief, Elsevier Optical Switching and Networking Journal (2004-2017); Associate Editor, IEEE/OSA Journal of Communications and Networking (2010-2012); Co-Guest Editor, JCM Journal of Communications, Special Issue on the "Advances in Communications and Networking," vol. 6, no. 9, December 2011; Associate Editor, IEEE/ACM Transactions on Networking (2000-2004); Associate Editor, Computer Networks

(2001-2004); Associate Editor, Optical Networks (2000-2004); and Co-Guest Editor, IEEE Journal on Selected Areas in Communications, Special Issue on “Protocols for Next Generation Optical WDM Networks,” vol. 18, no. 10, October 2000.

18. I have graduated twenty-five Ph.D. students. Two have received Ph.D. dissertation awards, one has received an NSF Career award, one became an NSA Fellow, and two have been inducted in the NC State Computer Science Alumni Hall of Fame. Three of my former Ph.D. students became Assistant Professors upon graduation, and the rest joined significant technology companies or research institutes, including RENCi (UNC-Chapel Hill), IBM Research, Google, Facebook, Cisco, Oracle, Ericsson, Riverbed Technologies, Sprint, and Sierra Wireless, among others. I have also graduated twelve M.S. thesis students.

19. During the course of my career, I have had more than 220 scientific articles, three books, and ten book chapters published, which have collectively received more than 9,800 citations (Google Scholar, November 17, 2023). These are summarized in my curriculum vitae.

III. Materials Considered

20. The analysis provided in this Declaration is based on my education as well as my experience in this field. In addition to relying on my knowledge and experience in the relevant field, I have considered the documents described in this

Declaration, the evidence cited in the Petition and the supporting declaration of Dr. Bhattacharjee (Ex. 1004), and the evidence being submitted with Patent Owner's Response.

IV. Level of Ordinary Skill in the Art

21. I understand that my analysis of the '602 patent and the interpretation of the claims of that patent must be done from the perspective of a person of ordinary skill in the art ("POSA") of the '602 patent as of the time of the priority date of the '602 patent. I understand that the priority date of the '602 patent is May 6, 2005, as the '602 patent claims priority to an application filed on that date. '602 patent at 1:5-15.

22. I understand that the hypothetical person of ordinary skill in the art is considered to have the normal skills and knowledge of a person in a certain technical field. I understand that factors that may be considered in determining the level of ordinary skill in the art include: (1) the education level of the inventor; (2) the types of problems encountered in the art; (3) the prior art solutions to those problems; (4) rapidity with which innovations are made; (5) the sophistication of the technology; and (6) the education level of active workers in the field. I also understand that "the person of ordinary skill" is a hypothetical person who is presumed to be aware of the universe of available prior art.

23. I also understand the level of ordinary skill in the art can be evidenced by the prior art. Accordingly, I have also considered the prior art discussed herein in determining the level of ordinary skill in the art.

24. In my opinion, a POSA with respect to the '602 patent would have had a bachelor's degree in computer science, computer engineering or an equivalent, as well as two years of professional experience, and lack of work experience could be remedied by additional education or vice versa. In my opinion, a POSA would have had a working knowledge of hardware and software for packet-switched networking, MPLS, and LAG. I understand that the Petition and Dr. Bhattacharjee's declaration purport to apply this same definition of a POSA.

V. Patent Law Standards

25. I understand that the Petitioners have the burden to prove a proposition of unpatentability by a preponderance of the evidence. I further understand that Petitioners have asserted unpatentability on only obviousness grounds.

26. I understand that the first step in an obviousness analysis is to construe the claim and that the second step is to compare the properly construed claim to the prior art reference. I understand that in an IPR, claim terms "shall be construed using the same claim construction standard that would be used to

construe the claim in a civil action ... , including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b). I understand that this is also referred to as the *Phillips* standard as explained in the case *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). I have applied this standard in rendering my opinions herein. I am informed that this standard dictates that claim terms are given their ordinary and customary meaning, as would be understood by a POSA in the context of the entire disclosure or specification of the patent, unless the inventor, as a lexicographer, has set forth a special meaning for a term. I understand that a patent’s “specification” includes all the figures, discussion, and claims within the patent document.

27. I understand that the prior art must disclose the patented subject matter with sufficient detail such that its existence in the prior art reference would be understood by a POSA.

28. I understand that the test of obviousness is whether the claimed invention, as a whole, would have been obvious to a POSA as of the date of the invention in light of the prior art. I understand that the use of hindsight must be avoided when considering whether the alleged invention would have been obvious to a POSA.

29. I understand that the obviousness analysis involves several factual inquiries: (i) the scope and content of the prior art; (ii) the differences between the prior art and the claimed invention; (iii) the level of ordinary skill in the art at the time of the invention; and (iv) the existence of objective indicia of nonobviousness (“secondary considerations”), such as unexpected results, long felt but unresolved need, failure of others, and industry skepticism followed by acceptance.

30. I understand that in order for a prior art reference to be relied upon as a basis for obviousness, the reference must be analogous art—that is, it must be in the same field of endeavor as the challenged patent or must be reasonably pertinent to the particular problem with which the challenged patent was concerned.

31. In connection with obviousness, I have been informed that there should be some reason or motivation that would have led a POSA to combine or modify the relevant prior-art teachings to obtain the claimed invention, including for obviousness based on a single prior art reference. I have been further informed that there should be explanation as to how the relevant prior art teachings would be modified or combined and work together to obtain the claimed invention. I have been further informed that a prior art reference must be considered in its entirety, including portions that would teach or lead away from the claimed invention.

32. Furthermore, I have been informed that there must be a reasonable expectation of success that a person having ordinary skill in the art would have

obtained the claimed invention based on the teachings of the prior art. I understand that in order to possess the requisite reasonable expectation of success in making the claimed invention as a whole, the POSA must be motivated to do more than merely vary all parameters with no indication of critical parameters or try all of a number of possible choices with no direction until successful. I understand that the prior art must provide more than a mere “general guidance” that seems to be a “promising field of experimentation.” I have been further informed that a reasonable expectation of success is separate from a motivation to modify or combine, and that obviousness requires a plausible rationale as to why the prior art references would have worked together.

33. I understand that it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered.

34. I understand that a dependent claim incorporates and thus includes all elements of the claim(s) from which it depends. I understand that for determining whether a dependent claim is anticipated or obvious, all elements of the dependent claim must be analyzed, including elements incorporated into the dependent claim based on its dependency from an independent claim.

VI. Claim Construction

35. I have reviewed the '602 patent and its prosecution history, as well as the materials referenced above in section III.

36. I understand that the Petition and Dr. Bhattacharjee’s declaration purport that no claim term requires express construction for purposes of this IPR. For purposes of my Declaration, I accept and adopt that position. I have applied the claim construction standards detailed above in rendering my opinions herein.

37. I also understand that in the context of the ’602 patent, a district court has previously construed the terms in the following table. Ex. 2001 at 3-4. These constructions apply equally to my opinions herein.

Term	District Court’s Construction
“RSVP-TE <i>’602 patent, claims 3, 15</i>	“RSVP-TE protocol described in IETF RFC 3209.”
Preamble <i>’602 patent, claim 15</i>	The preamble is not limiting.

VII. The ’602 Patent

38. I understand the ’602 patent to be directed to tunnel provisioning with link aggregation, particularly with respect to a link aggregation group (LAG) in a multi-protocol label switching (MPLS) network. ’602 patent at Title, Figs. 1A-1B, 1:17-3:29, claims 1-26. The ’602 patent describes multiprotocol label switching (1:25-67) and link aggregation (2:1-25), discloses embodiments of an MPLS network containing a LAG between two MPLS/LAG switches (e.g., Figs. 1A-1B, 3:40-45), and recites claims directed to methods and apparatuses for assigning and utilizing a single physical tunnel port of a LAG that connects MPLS/LAG switches

(e.g., claims 1, 15, 26). As recognized by the U.S. Patent and Trademark Office, the claimed inventions of the '602 patent were new and inventive at the time of the priority date. A POSA would have understood the claimed inventions of the '602 patent to improve the utilization and efficiency of a LAG in an MPLS network.

39. More specifically, independent claim 1 is directed to a method for assigning and utilizing a physical tunnel port in a Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, including, in part:

(limitation 1.1)¹ a “first MPLS/LAG switch” assigning a “single physical tunnel port of a LAG” to a “network tunnel”; (1.2 & 1.3) said “first MPLS/LAG switch” preparing and sending a “data packet label” to a “preceding node” with the port serial number of the assigned “single physical tunnel port” encoded in the “data packet label”; (1.4) said “first MPLS/LAG switch” receiving from the “preceding node” a “data packet” comprising said “data packet label”; and (1.5) said “first MPLS/LAG switch” sending said “data packet” “from said first MPLS/LAG switch to a second M[]PLS/LAG² switch via said single physical tunnel port.”

40. Independent claim 26 is a method claim similar to claim 1 and includes limitations similar to those of claim 1 noted above, plus additional

¹ For purposes of this Declaration, I use the same claim limitation numbering as the Petition.

² The claim term “second M[]PLS/LAG switch” in claims 1 and 26 is written corrected as “second MPLS/LAG switch” with alteration omitted throughout this Declaration.

limitation 26.1, which recites an initial step of the “first MPLS/LAG switch” receiving from the “preceding node” a “request message” that requests configuration of the “network tunnel,” requests the “data packet label” associated with said “network tunnel,” and specifies a “bandwidth requirement.”

41. Independent claim 15 is an apparatus claim similar to method claim 1 and recites an apparatus for assigning and utilizing a physical tunnel port in a Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, with the LAG connected to a second MPLS/LAG switch. Claim 15 first recites a “processor” configured to, in part: (15.2) assign a “single physical tunnel port of a LAG” to a “network tunnel”; and (15.2 & 15.3) publish a “[data] packet label” “upstream” with the port serial number of the assigned “single physical tunnel port” encoded in the “data packet label.” Claim 15 further recites a “mapper” configured to, in part: (15.6) receive a “data packet” from an “upstream node”; and (15.8) if said “data packet” contains said “data packet label,” then send said “data packet” “to the second MPLS/LAG switch via said single physical tunnel port.”

VIII. Ground 1: Raz Does Not Render Obvious Claims 1-13, 15-24, 26

42. I understand that in Ground 1, Petitioner asserts that claims 1-13, 15-24, and 26 are obvious over Raz (Ex. 1006, “Raz”). But Raz does not render obvious claims 1-13, 15-24, and 26, including because (i) Raz and the claimed inventions of the ’602 patent are fundamentally different, (ii) a POSA would not

have modified Raz to arrive at the claimed inventions of the '602 patent, (iii) Petitioner has failed to establish a motivation to modify Raz to arrive at the claimed inventions of the '602 patent, and (iv) Petitioner has failed to establish a reasonable expectation of success for any such modifications. Further, I explain below particular limitations of independent claims 1, 15, and 26 that Raz does not teach or render obvious.

A. Raz and the Claimed Inventions of the '602 Patent Are Fundamentally Different

43. A POSA would have understood that Raz and the claimed inventions of the '602 patent are fundamentally different.

44. Independent claim 1 of the '602 patent is a method claim that recites: “[1.0] A method for assigning and utilizing an Ethernet physical data port in an Ethernet Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, the method comprising the steps of:

- [1.1] assigning, by a first MPLS/LAG switch, a single physical tunnel port of a LAG to a network tunnel, wherein the single physical tunnel port of the LAG meets a bandwidth requirement of the network tunnel, and wherein said single physical tunnel port of the LAG has a port serial number;
- [1.2] dedicating a sub-set of bits in a data packet label prepared by the first MPLS/LAG switch to encode said port serial number of said single physical tunnel port of the LAG into the data packet label;
- [1.3] sending, by said first MPLS/LAG switch, the data packet label, in which said port serial number of said single physical tunnel port is encoded, to a preceding node;

- [1.4] receiving from the preceding node, by said first MPLS/LAG switch, a data packet comprising said data packet label, in which said port serial number of said single physical tunnel port is encoded; and
- [1.5] sending said data packet from said first MPLS/LAG switch to a second MPLS/LAG switch via said single physical tunnel port having the port serial number encoded in the data packet label.”

45. Independent claim 15 of the '602 patent is an apparatus claim that is similar to claim 1. Claim 15 recites: “[15.0] An apparatus for assigning and utilizing an Ethernet physical data port in an Ethernet Link Aggregation Group (LAG) located downstream from a preceding node in a Multi-Protocol Label Switching (MPLS) network tunnel employing Resource Reservation Protocol Traffic Engineering (RSVP-TE) tunnel provisioning, the LAG having a first MPLS/LAG switch and a second MPLS/LAG switch, the apparatus comprising:

- [15.1] a processor, which is configured to:
 - [15.2] assign a single physical tunnel port of a LAG to a network tunnel, wherein said single physical tunnel port meets a bandwidth requirement of the network tunnel, and wherein said single physical tunnel port has a port serial number;
 - [15.3] dedicate a sub-set of bits in a data packet label to encode said port serial number of said single physical tunnel port of the LAG into the data packet label;
- [15.4] publish said packet label upstream; and
- [15.5] a mapper, which is configured to:
 - [15.6] receive a data packet from an upstream node;
 - [15.7] detect said data packet label in said data packet; and
 - [15.8] if said data packet contains said data packet label, send said data packet to the second MPLS/LAG switch via said single physical tunnel port.”

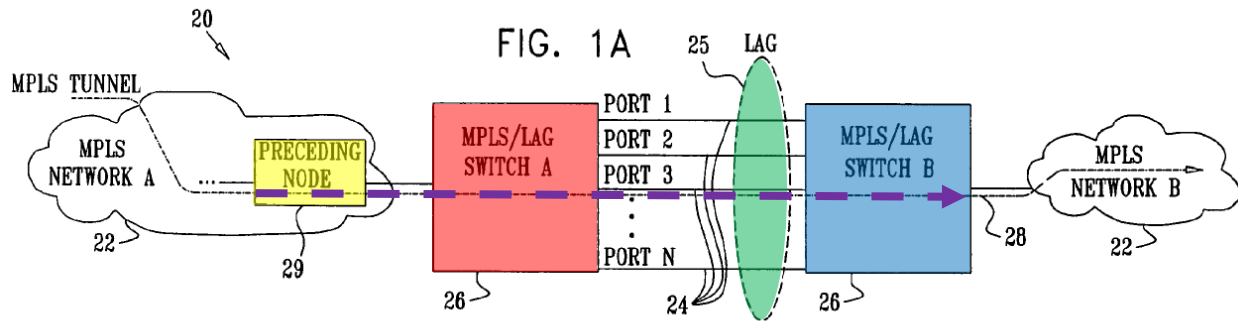
46. Independent claim 26 of the '602 patent is a method claim that is similar to claim 1, as claim 26's limitations 26.2–26.6 are substantially similar to limitations 1.1–1.5, except that claim 26 includes an additional limitation not included in claim 1, i.e., limitation 26.1. Claim 26 recites: “[26.0] A method for assigning and utilizing an Ethernet physical data port in an Ethernet Link Aggregation Group (LAG) in a Multi-Protocol Label Switching (MPLS) network, the method comprising the steps of:

- [26.1] receiving from a preceding node located upstream from a first MPLS/LAG switch, at said first MPLS/LAG switch, a request message requesting configuration of a network tunnel, the message further requesting a data packet label associated with said network tunnel, said request message specifying a bandwidth requirement;
- [26.2] assigning, at the first MPLS/LAG switch, a single physical tunnel port of a LAG to the network tunnel wherein the single physical tunnel port of the LAG, which meets the specified bandwidth requirement, wherein said single physical tunnel port of said LAG has a port serial number;
- [26.3] dedicating a sub-set of bits in a data packet label prepared by said first MPLS/LAG switch to encode said port serial number of said single physical tunnel port of the LAG into the data packet label;
- [26.4] sending, by said first MPLS/LAG switch, said data packet label, in which said port serial number of said single physical tunnel port is encoded, to the preceding node;
- [26.5] receiving from the preceding node, at said first MPLS/LAG switch, a data packet that includes said data packet label, in which said port serial number of said single physical tunnel port is encoded; and

[26.6] sending said data packet from said first MPLS/LAG switch to a second MSPLS/LAG switch via said single physical tunnel port having the port serial number encoded in the data packet label.”

47. As shown by the independent claims recited above, the ’602 patent claims are directed to methods and apparatuses for assigning and utilizing a “single physical tunnel port” of a Link Aggregation Group (“LAG”) connecting a “first MPLS/LAG switch” to a “second MPLS/LAG switch” in a Multi-Protocol Label Switching (“MPLS”) network. ’602 patent at claims 1, 15, 26. The claims comprise sending to a “preceding node” (or publishing “upstream”) a data packet label identifying an assigned “single physical tunnel port”; receiving from the “preceding node” or “upstream node” a data packet containing the data packet label; and sending the data packet from the “first MPLS/LAG switch” to the “second MPLS/LAG switch” “via said single physical tunnel port.” *Id.*

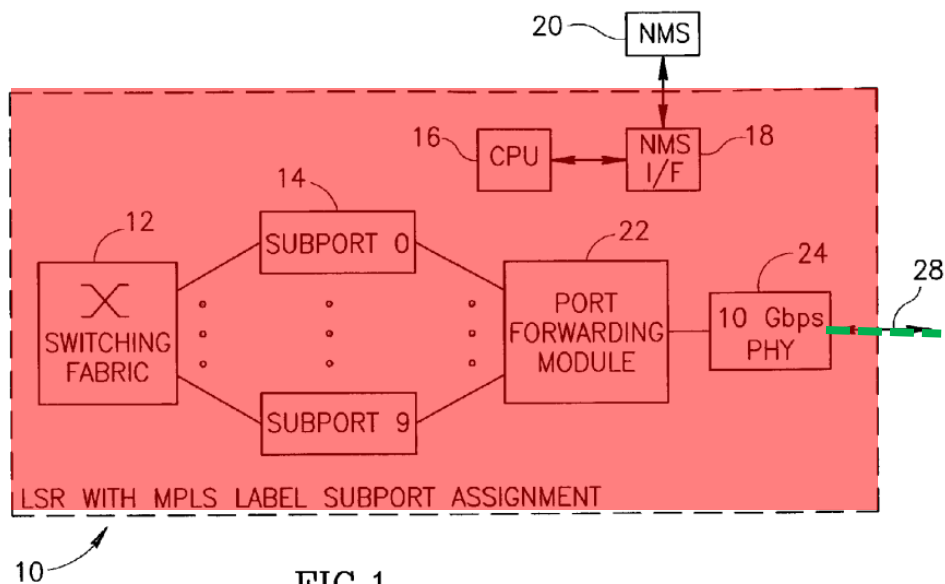
48. Below is an annotated version of the ’602 patent’s Figure 1A that illustrates these limitations of the independent claims. This annotated figure demonstrates how the claimed LAG (green) is between and links MPLS/LAG switches A and B (red and blue, respectively), with data packets containing a certain data packet label being transmitted along an MPLS tunnel (dashed purple line) from the preceding node (yellow) to the first MPLS/LAG switch A (red) and then via an assigned physical Ethernet port #3 of the LAG (green) to the second MPLS/LAG switch B (blue).



'602 patent at Fig. 1A (annotated), 3:58-4:34. This Figure 1A is discussed in the '602 patent at 3:58-4:34.

49. It is my opinion that Raz, however, does not teach or suggest a LAG of physical tunnel ports to begin with, much less sending data packets from a first MPLS/LAG switch to a second MPLS/LAG switch via an assigned physical tunnel port of a LAG as the independent claims recite. Instead, Raz is directed to using multiple slow-speed processors (i.e., “subports”) *within* a network device such as an LSR (label switching router) for processing a *single* high-speed stream between LSRs. Raz at Abstract, 1:40-2:8, 6:24-33. For example, Raz at 6:24-33 states that “[t]he present invention provides a ... mechanism whereby a plurality of subports comprising slower speed processors are used to perform the packet processing for a higher speed packet stream,” and Raz at 1:40-2:8 explains that these subports or processors are for use within a network device for processing a single high-speed packet stream or link between network devices.

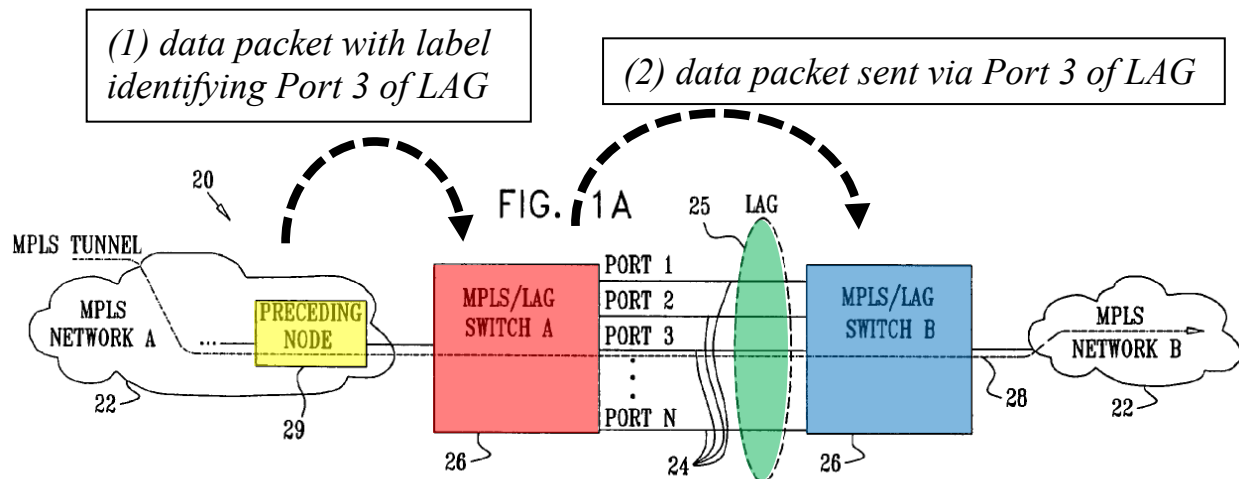
50. Raz's teaching of using multiple slow-speed subports *within* an LSR for processing a *single* high-speed stream between LSRs is demonstrated by Raz's Figures 1 and 3. Below is an annotated version of Raz's Figure 1 that illustrates this teaching. As shown by this annotated Figure 1, Raz is directed to LSRs connected via a *single* high-speed (10G) link 28, not a LAG, and Raz uses a plurality of slow-speed (1G) subports 14 *within* an LSR for processing data that is received or sent via that single high-speed link 28.



Raz at Fig. 1 (annotated), 6:65-7:10, 7:59-64. Additionally, Raz's teaching referenced above is similarly demonstrated by Raz's Figure 3, which shows pairs of LSRs each connected via a *single* high-speed (10G) link (60 or 68), not a LAG, and with multiple subports contained *within* the LSRs on each side of those high-speed links for purposes of processing data that is received or sent via those high-speed

links. Raz at Fig. 3, 9:29-40. Indeed, a POSA would not have understood the single high-speed (10G) link 28 of Raz's Figure 1 or the single high-speed (10G) links 60 and 68 of Raz's Figure 3 to be a LAG. Raz at Figs. 1, 3, 6:65-7:10, 9:29-40.

51. Even disregarding the fact that Raz does not teach or suggest a LAG of physical tunnel ports or MPLS/LAG switches, as explained above, it is my opinion that Raz is nonetheless fundamentally different than the '602 patent claims when considering packet labeling and how packets are processed by Raz's subports versus transmitted via the '602 patent's "single physical tunnel port." As explained above, the '602 patent recites (1) sending from a preceding node to a first MPLS/LAG switch a data packet with a label identifying a particular physical tunnel port of a LAG between the first MPLS/LAG switch and a second MPLS/LAG switch, and then (2) sending the data packet from the first MPLS/LAG switch to the second MPLS/LAG switch via the physical tunnel port that is assigned by the first MPLS/LAG switch and identified in the data packet label. This is demonstrated by the annotated version of the '602 patent's Figure 1A below, which shows how the preceding node (yellow) sends to the first MPLS/LAG switch (red) a data packet with a label identifying Port 3 of a LAG (green) between the first MPLS/LAG switch (red) and a second MPLS/LAG switch (blue), and then that data packet is sent from the first MPLS/LAG switch (red) to the second MPLS/LAG switch (blue) via that Port 3 of the LAG (green).



'602 patent at Fig. 1A (annotated), 3:58-4:34, claims 1, 15, 26.

52. It is my opinion that Raz, however, does not teach those limitations. Instead, Raz teaches (1) sending from a preceding LSR to a first LSR a data packet with a label that identifies the subport for internally processing data sent/received between the preceding LSR and first LSR, not between the first LSR and some second LSR, and then (2) if the data packet is sent from that first LSR to some second LSR, it is processed by another subport that is chosen by the second LSR, not the subport assigned by the first LSR and identified in the label sent from the preceding LSR. Raz at 9:29-10:4, 7:17-45, 8:47-55, 2:18-20. Below is an annotated version of Raz's Figure 3 that illustrates these teachings of Raz. As shown by the provisioned path represented by dotted line 53 in Figure 3 below, along with the annotations, a data packet sent from LSR A to LSR B has a label identifying subport 0—i.e., the subport for internally processing data sent/received

between LSR A and LSR B, not between LSR B and LSR C. Raz at 9:29-10:4.

When that data packet is then sent from LSR B to LSR C, it is processed not by subport 0, which was chosen by LSR B, but instead by subport 1, which is chosen by LSR C. *Id.*

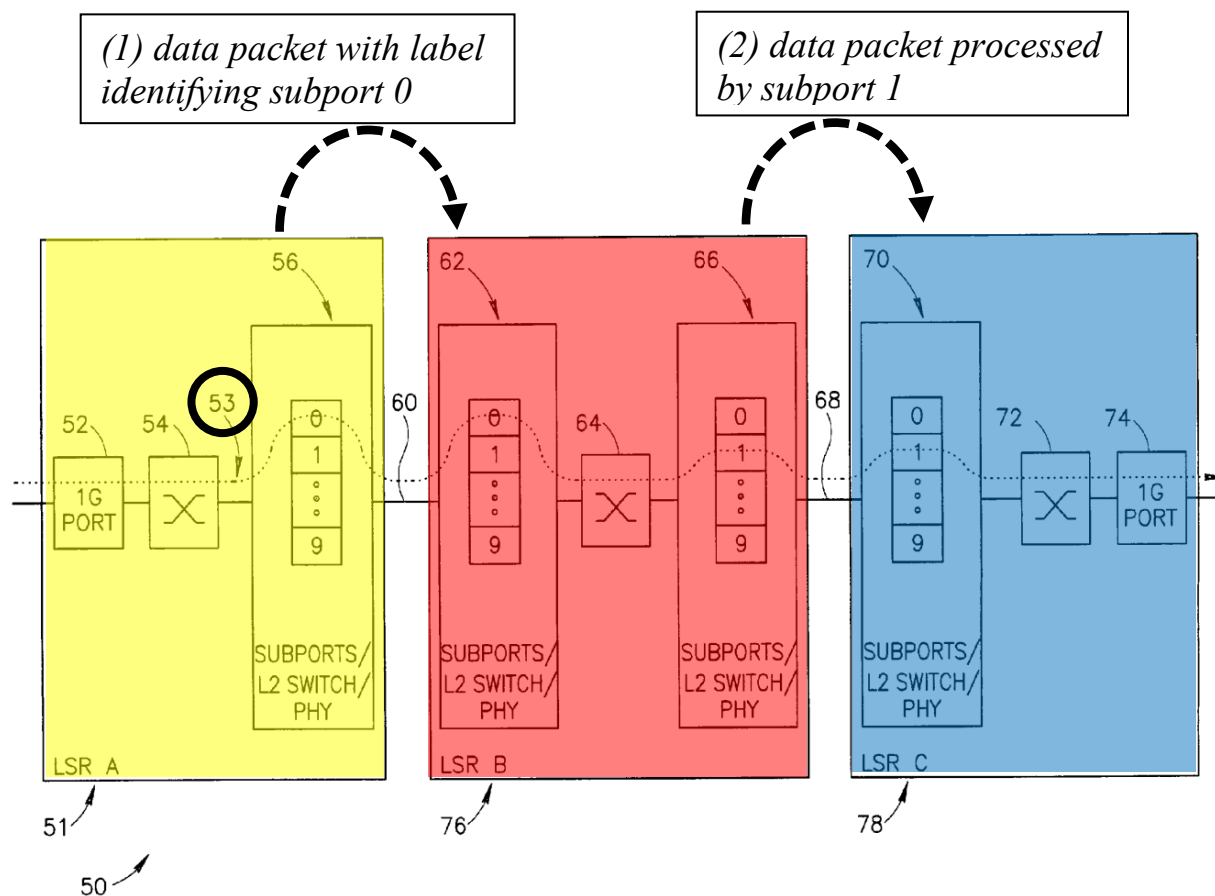


FIG.3

Raz at Fig. 3 (annotated), 9:29-10:4. As explained and demonstrated above, Raz teaches that a given LSR selects only the subport used for *receiving* data packets at the given LSR from a preceding node, and the subport used for transmitting data packets from the given LSR to the next LSR is independently chosen by that next

LSR. Raz at 7:17-45, 8:44-55, 9:29-10:4, 2:18-20, 6:43-45. Indeed, Raz discloses that “it is the downstream (i.e. receiving) node that determines the subport it wants to receive the LSP on” and “[t]he subports used on both sides of the next hop ... are independent,” such that “the subports may be different for each hop of the connection.” Raz at 7:26-27, 2:18-20; *see also* Raz at 6:43-45 (“The subports used on both sides of the *next hop* ... are independent of the *current hop*.” (emphases added)).

53. It is my opinion that a POSA would have understood that, as explained above, Raz is fundamentally different from the ’602 patent’s claimed inventions because Raz does not teach or suggest either (i) a LAG with physical tunnel ports connecting two MPLS/LAG switches to begin with or (ii) the specific claim limitations involving sending from a preceding node to a first MPLS/LAG switch a data packet with a label identifying an assigned physical tunnel port through which the data packet is then sent to a second MPLS/LAG switch.

B. A POSA Would Not Have Modified Raz to Arrive at the Claimed Inventions of the ’602 Patent

54. It is my opinion that a POSA would not have been motivated to modify Raz’s teachings to apply to communication via a LAG in an MPLS network between two MPLS/LAG switches, as recited in the independent challenged claims of the ’602 patent.

55. In my opinion, a POSA would have understood that Raz is specifically and solely directed to a provisioning mechanism for *inside* a network device such as an LSR. A POSA would have thus understood that Raz teaches away from applying its subport-related teachings to an external LAG link between two LSRs. Raz explains its premise is that multiple “internal” “existing” circuits/processors are needed to keep up with a “high speed packet stream.” Raz at 1:40-62. Then, based on that premise, Raz provides a “forwarding and provisioning mechanism that enables a high speed packet stream to be processed by multiple processors that operate at a slower rate tha[n] the inbound packet stream.” Raz at 1:40-62; *see also* Raz at Abstract, 6:24-27. And Raz makes clear that those “slower rate” “multiple processors” (Raz at 1:56-59) refer to its subports. *See, e.g.*, Raz at 6:24-47 (“The present invention provides a subport forwarding and provisioning mechanism whereby a plurality of subports comprising slower speed processors are used to perform the packet processing for a higher speed packet stream.”). A POSA would have therefore understood that Raz is specifically directed to using multiple subports (i.e., processors) to increase the *internal* processing capacity of an LSR to match an external high-speed link between LSRs.

56. It is my opinion that a POSA would not have been motivated by Raz to use multiple *external* links to increase the bandwidth *between* LSRs (e.g., a

LAG) because Raz describes that the capacity of such external links or streams between LSRs already exceeds the capacity of internal processors. Raz at 1:40-51 (describing a “problem” in which external link speeds “exceed the capacity” of existing internal processors). In fact, Raz emphasizes that Raz’s subport-related invention is intended to be implemented *within* an LSR, not between LSRs, as Raz states: “it is intended that the mechanism of the present invention be implemented *in* network devices such as ... LSRs ... making up the nodes in a network.” Raz at 6:51-54. Thus, a POSA would not have used Raz for implementing a LAG *between* LSRs.

57. Another reason why a POSA would not have been motivated to modify Raz as Petitioner asserts is because the POSA would have understood that Raz addresses a completely different problem than the ’602 patent. This difference is based on how Raz and the ’602 patent treat link speed and processor speed. A POSA would have understood that the ’602 patent deals with relatively low link speeds and aggregates them to form a higher speed link, i.e., a LAG. Additionally, a POSA would have understood that the ’602 patent and the LAG recited therein assume that the LSR or switch on each end of the LAG link has sufficient processing capacity to handle the traffic transmitted on the LAG link. A POSA would have understood that Raz, however, deals with the opposite problem: how to handle a high-speed link using slow-speed processors. Raz at Abstract, 1:40-2:3,

6:24-27, 14:6-8, 15:14-17, 16:27-29. A POSA would have understood that this problem that Raz addresses does not arise for a LAG, and thus the '602 patent, because a LAG does not use a single high-speed link but instead uses multiple low-speed links to make up a high-speed link, thus obviating the need for Raz's forwarding and provisioning mechanism that splits a single high-speed link for processing by multiple slower-speed processors/subports. Raz at Abstract, 1:40-2:3, 6:24-27. A POSA would have understood that link aggregation using a LAG leverages the fact that switches can have multiple input/output ports, each at, for example, 1G. A LAG aggregates multiple of such low-speed 1G links together to get a high-speed 10G link. Once the LAG is in place, the problem that Raz faces does not arise because there is not a *single* high-speed 10G link that needs to be split and provisioned for processing by the low-speed speed 1G processors, i.e., there is no need for Raz's mechanism. So a POSA would not have used Raz's disclosure for a system that involves a LAG and therefore would not have looked to Raz for solutions regarding a LAG in an MPLS network, as recited in the '602 patent's claims.

58. Another reason why a POSA would not have been motivated to modify Raz as Petitioner asserts is because the '602 patent's claims are specifically directed to improving an MPLS network, but Raz's invention is indifferent to, and outside the purview of, MPLS network engineering. A POSA would have

understood that the '602 patent is concerned with transmission of MPLS packets via a LAG that connects two MPLS/LAG switches. A POSA would have further understood that this transmission of packets *between* two such switches is strictly **within the purview of the MPLS protocol**, as the MPLS protocol is concerned with making sure that packets are correctly routed between a source and destination, and therefore it must ensure that packets are correctly transmitted on a LAG between two switches or LSRs. As explained in section VII above, a POSA would have understood the claimed inventions of the '602 patent to improve the utilization and efficiency of a LAG link in an MPLS network.

59. A POSA would have understood that Raz, however, is concerned with packet processing within a switch and more specifically, processing data transmitted on a high-speed link when the LSR does not have a high-speed processor to handle it. Raz at Abstract, 1:40-2:3 (explaining that “[s]ingle-chip network processors fast enough to process [a 10 GE] input packet stream may not be available and/or are cost prohibitive”), 6:24-27. A POSA would have understood that this operation *within* a switch, as disclosed by Raz, is **outside the purview of MPLS**. A POSA would have understood that Raz does not provide any solution that would help improve the utilization or efficiency of how an MPLS network handles a LAG link, and therefore, a POSA interested in MPLS network engineering would not have considered Raz. Indeed, a POSA would have

recognized that Raz teaches that its invention is not specifically directed or limited to MPLS networks. Raz at 2:27-32 (“It is important to note that the invention [of Raz] is not limited by the type of network in use,” and “applicable networks include” non-MPLS networks.), 6:46-50, 14:6-32. Further, a POSA would have recognized that to the extent Raz’s disclosures do involve MPLS, it is not to *improve* MPLS network engineering but rather merely to *accommodate* an MPLS network. Raz at 1:52-55 (disclosing that Raz sought an invention that would merely be “able to handle” the MPLS protocol), 2:3-5, 6:27-29.

60. Another reason why a POSA would not have been motivated to modify Raz as Petitioner asserts is because, based on the fundamental differences described in section VIII.A above, a POSA would have understood that applying Raz’s teachings regarding its subports to communications between two MPLS/LAG switches would have rendered Raz inoperable or unsatisfactory for its intended purpose.

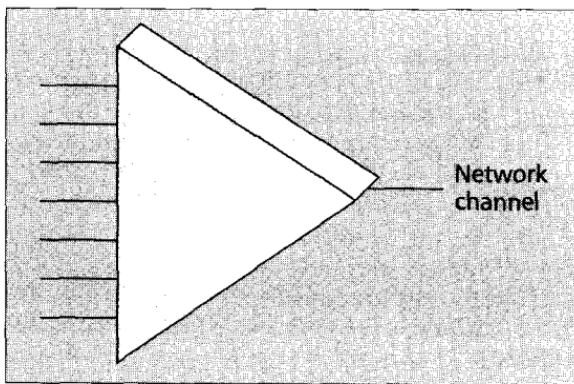
61. As one example, a POSA would have understood that Raz involves multiplexing (which Raz refers to as “aggregating”) the outputs of its slow-speed subports into a single high-speed stream. Raz at 1:1-8, 1:65-66, Abstract, 2:11-13, 2:47-48, 2:63-64, 6:24-27, 6:36-38, 14:19-22; *see* Ex.2009 at 473; Ex.2010 at 43, Fig. 1; Ex.2011. Indeed, Raz includes “Multiplexing” in its title and states that the “present invention” relates to a “link multiplexing mechanism.” Raz at 1:1-8,

1:65-66. As explained by Exhibit 2009, “conventional multiplex[ing] combines various independent low-speed channels from different sources into one high-speed link,” just as Raz combines the outputs of its low-speed subports into one high-speed link. Ex.2009 at 473; *see also* Ex.2010 at 43 (“multiplexing involves the aggregation of several independent channels into a high-data-rate network channel”), Fig. 1; Ex.2011³ (“multiplexing combines multiple signals into a single signal”).

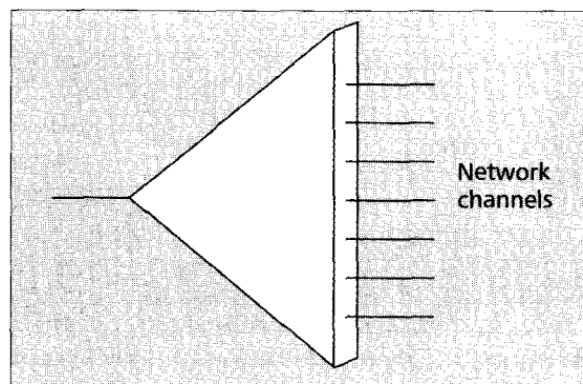
62. But a POSA would not have done this—i.e., used Raz’s multiplexing—with data transmitted over the various physical tunnel ports of a LAG, and further, a POSA *could not* have performed multiplexing using data transmitted over a “single physical tunnel port” as recited in the challenged claims, as multiplexing constitutes combining multiple streams, as described above. Ex.2009 at 473; Ex.2010 at 43, Fig. 1; Ex.2011. In fact, Raz’s multiplexing of subport outputs into a single stream is the *opposite* of a LAG, which is a form of *inverse* multiplexing. *See* Ex.2011 (“While multiplexing combines multiple

³ I note that while Exhibit 2011 does not constitute prior art to the ’602 patent, the substantive content in the first paragraph of Exhibit 2011—i.e., regarding multiplexing, Inverse Multiplexing for ATM (IMA), and the difference between multiplexing and IMA—was known by persons of ordinary skill in the art prior to the priority date of the ’602 patent, as demonstrated by Exhibit 2009, which shows that IMA is a technology that existed prior to the priority date and for which the definitions have not changed since then. Ex.2011; Ex.2009 at Abstract (explaining IMA technology), 473 (explaining the difference between multiplexing and inverse multiplexing, such as IMA).

signals into a single signal, [inverse multiplexing] divides a data stream into multiple concurrent streams that are transmitted at the same time across separate channels”); Ex.2009 at Abstract, 473 (“Inverse Multiplex[ing] is the reverse of multiplexing, because it involves breaking a ... signal into a number of smaller and independent low-cost channels for transmission”); Ex.2010 at 43 (explaining that “multiplexing involves the aggregation of several independent channels into a high-data-rate network channel,” whereas “channel aggregation [i.e., inverse multiplexing] ... is the process of implementing a high-speed channel by splitting it into several network channels at lower speeds”), Figs. 1-2. Exhibit 2010 illustrates the fact that Raz’s multiplexing of subport outputs into a single stream for transmission across a single network link, as depicted below in Figure 1 of Exhibit 2010, is the opposite of inverse multiplexing, such as the claimed LAG, which contains multiple parallel network links, as depicted below in Figure 2 of Exhibit 2010.



■ Figure 1. *Multiplexer symbol.*



■ Figure 2. *Inverse multiplexer.*

Ex.2010 at Figs. 1-2.

63. As another example of why applying Raz's subport-related teachings to communications between two MPLS/LAG switches would have rendered Raz inoperable or unsatisfactory for its intended purpose, a POSA would have understood that Raz's forwarding and provisioning mechanism involves using the same subport for processing a data packet on both sides of a link between two LSRs. Raz at Fig. 3, 2:15-16, 6:38-41, 7:20, 8:46-47. Indeed, Raz teaches that "[t]he selected subport is the same for both sides of a 10G link." Raz at 7:20, 8:46-47. This is demonstrated by Raz's Figure 3, which shows that that subport selected by LSR B (i.e., subport 0) is used by LSR A's subport 0 and LSR B's subport 0 to process a packet sent from LSR A to LSR B, and the subport selected by LSR C (i.e., subport 1) is used by LSR B's subport 1 and LSR C's subport 1 to process a packet sent from LSR B to LSR C. Raz at Fig. 3, 9:41-10:4. But a POSA would have understood that this cannot be done if Raz's subports constitute the link itself between LSRs, as Petitioner asserts. That is, if Raz's subports themselves constitute a link between two LSRs, then it is not possible to process a data packet with the same subport on both sides of the link as Raz teaches because the subports are not on either side of the link.

64. I understand that Petitioner asserts that communication between LSRs is done in the "same way" as within an LSR. Pet. 15, 19. However, as described

above, a POSA would have understood that for Raz's teachings, communication between LSRs cannot be done in the "same way" as within an LSR.

C. Petitioner Fails to Establish a Motivation to Modify Raz to Arrive at the Claimed Inventions of the '602 Patent

65. Based on my review of the Petition and evidence cited therein, the Petition fails to establish that a POSA would have modified Raz at all, let alone to arrive at the claimed inventions of the '602 patent.

66. I have been informed that obviousness based on only a single reference nonetheless requires a showing of motivation to modify the reference to meet the claims.

67. It is my opinion that the section of the Petition regarding independent claim 1, and evidence cited therein, fails to establish that a POSA would have modified Raz to meet claim 1. Pet. 12-25. Also, it is my opinion that the section of the Petition regarding independent claim 15, and evidence cited therein, fails to establish that a POSA would have modified Raz to meet claim 15. Pet. 40-48. Also, it is my opinion that the section of the Petition regarding independent claim 26, and evidence cited therein, fails to establish that a POSA would have modified Raz to meet claim 26. Pet. 49-52. The Petition does not explain specifically why or how a POSA would have modified the particular teachings of Raz to meet any of the independent claims.

68. Based on my review of the Petition, I understand that the Petition does not mention “modify” at all. Further, based on my review of the Petition, I understand that the Petition only mentions “motivat[ion]” three times for independent claims 1, 15, and 26 under Ground 1—once for limitation 1.1 to assert that a POSA would have been motivated to assign a physical tunnel port of the alleged MPLS/LAG switch to a network tunnel (Pet. 19-20), once for limitation 1.2 to assert that a POSA would have been motivated to take Raz’s disclosure of dedicating bits for a subport and extend that to dedicating bits for a physical port of a MPLS/LAG switch (Pet. 22), and once for limitation 15.8 to assert that a POSA would have been motivated to communicate packets between first and second MPLS/LAG switches the same way packets are communicated between LSRs in Raz (Pet. 48). Each of these three assertions, however, assumes that Raz already includes, and is already being applied to, a LAG between two MPLS/LAG switches. But this assumption is not true because Raz does not teach or render obvious a LAG to a POSA, as I discuss in section VIII.A above and further in section VIII.E.1 below.

69. Below are my opinions regarding the various obviousness assertions in the Petition for independent claim 1 under Ground 1. *See* Pet. 12-25. These opinions are also relevant and applicable regarding independent claims 15 and 26 because independent claims 15 and 26 are substantially similar to claim 1 and I

understand that Petitioner relies on its obviousness analysis of claim 1 for purposes of claims 15 and 26. *See* Pet. 40-48 (incorporating, relying on, and parroting Petitioner’s analysis of claim 1 for claim 15), 49-52 (incorporating and relying on Petitioner’s analysis of claim 1 for claim 26).

70. **Preamble (Limitation 1.0)** — I understand that the Petition asserts the following regarding limitation 1.0:

While Raz discusses the utilization of subports in a LAG within a LSR to communicate high-speed packet streams ... , a POSA similarly would have known to use Ethernet physical data ports of a router or switch in an Ethernet LAG to communicate high-speed packet streams in a MPLS network. ... The concept of using aggregation to communicate ... through subports *within* a LSR also applies to communicating ... through Ethernet physical data ports *used to connect different* routers or switches in a MPLS network.

Pet. 15 (emphasis in original). **First**, however, a POSA would have understood that Raz does not use subports to “communicate high-speed packet streams” as Petitioner alleges but rather for ***internal processing*** of a high-speed packet stream within an LSR. Raz at 1:40-59, 2:1-2, 2:5-6, 6:25-29, 7:42-45, 7:59-64, 10:22-23, 12:66-13:5. Specifically, a POSA would have understood that, Raz uses subports to increase the internal processing capacity within an LSR to accommodate a high-speed packet stream between LSRs, as discussed in section VIII.B above. Raz at 1:40-59. **Second**, even assuming that Petitioner is correct that (i) “a POSA ... would have known to use ... an Ethernet LAG ... in a MPLS network” and (ii) “[t]he concept of using ... subports *within* a LSR also applies to ... Ethernet physical data ports *used*

to connect *different* routers or switches” (Pet. 15 (emphases in original)), that still does not explain *why* or *how* a POSA would have been motivated to modify the specific teachings of Raz to include a LAG between LSRs.

71. I understand that Petitioner also asserts that “packet streams are communicated within a LSR in *the same way* as they are communicated between routers and switches” and “[t]he teachings of Raz ... would have been directly applicable to communications between routers or switches in an Ethernet LAG in a MPLS network.” Pet. 15 (emphasis added) (citing Ex.1004 ¶82). **First**, however, it is my opinion that these assertions are conclusory, as Petitioner’s assertions include no explanation, in either the Petition nor the cited paragraph of Dr. Bhattacharjee’s declaration, as to how a POSA would purportedly apply Raz’s particular techniques for using subports *within* an LSR “in *the same way*” to communications *between* LSRs. **Second**, as I noted above, a POSA would have understood that Raz’s subports are not for “communicat[ing],” as Petitioner implies, but rather internal processing. Raz at 1:40-59; *see* section VIII.B *supra*.

72. **Third**, Petitioner’s assertion regarding “the same way” is not true. A POSA would have known that how packets are processed and move within a switch is different from how packet streams are communicated between switches, for at least three technical reasons:

- 1) As soon as an Ethernet frame containing an MPLS packet arrives at a switch, the Ethernet header and trailer is stripped off (an operation called

“decapsulation”) and only the MPLS packet is stored in a buffer (memory location) within the switch. Therefore, the MPLS packet stored in the switch is different than the Ethernet frame sent between switches.

2) Ethernet frames are serially transmitted bit-by-bit along each link; the Ethernet header and trailer are necessary so that the receiving switch will be able to determine where, in the stream of bits it receives, a frame starts and ends. Within a switch, on the other hand, there is no bit-by-bit transmission. Upon reception, each MPLS packet is stored individually in any memory location that is available at the time of its arrival; therefore, two MPLS packets transmitted in back-to-back Ethernet frames on the same link may be stored in two different and unrelated memory locations upon reception. To “move” a packet within a switch, a processor reads the packet from one memory location and copies it to another. Therefore, the “subports” of Raz are *not* transmission links. The processor of a subport simply *reads* a packet from the memory location where Raz’s port forwarding module stored it.

3) When communicating an Ethernet frame on a link between switches, the upstream switch serially transmits the bits of the entire frame. Ethernet frames (and the MPLS packets they contain) are of variable length, and switching variable-length packets is slow. Therefore, switches operating at Gigabit speeds, such as the switches of Raz and of the ’602 patent, typically do not switch the MPLS packets in their entirety. Instead, at the input port they fragment the packets into small fixed-size cells and switch each cell separately; at the output port the cells are then reassembled into the original packet (in a buffer).

Overall, the way an MPLS packet “moves” within a switch from the input port (where it is received from an Ethernet frame) to the output port (where it is reassembled to be forwarded to the downstream switch as another Ethernet frame) is completely different from, and unrelated to, how Ethernet frames are communicated (via serial bit-by-bit transmission) between switches.

Also, a POSA would have understood that Raz itself distinguishes between operations within an LSR and between LSRs, and Raz makes clear that its invention is specifically directed to internal processing within an LSR. Raz at Abstract, Fig. 3, 1:40-59. For example, Raz distinguishes between capacity of external links versus capacity of internal processors, as Raz is premised on the notion that a 10G link is acceptable but that a 10G single-chip processor may be unavailable or cost prohibitive. Raz at 1:40-49. And Raz's forwarding and provisioning mechanism is thus directed to "enabl[ing] a high speed packet stream to be processed by multiple [internal] processors that operate at a slower rate tha[n] the inbound packet stream." Raz at 1:56-59. Also, as discussed in section VIII.B above, a POSA would have understood that Raz teaches, for example, that the outputs of its subports are aggregated/multiplexed into a single stream for transmitting between LSRs. Raz at Abstract, Figs. 1-3, 2:11-13, 2:47-48, 2:63-64, 6:24-27, 6:36-38, 14:19-22. Also, as discussed in section VIII.B above, a POSA would have understood that Raz teaches, for example, that the same subport is used within both LSRs on respective sides of the link. Raz at Fig. 3, 2:15-16, 6:38-41, 7:20, 8:46-47. A POSA would have understood that these two operations with an LSR—i.e., the multiplexing of Raz's subport outputs into a single stream and the use of the same subports in LSRs on each side of a link—are not, and cannot be, "the same as" communications between two LSRs. Based on my review of the Petition, it does not and cannot explain how

these two teachings of Raz regarding operations within an LSR are “the same as” communications between two LSRs, much less between two MPLS/LAG switches via a single physical tunnel port of the LAG. Based on just these two teachings alone, a POSA would have understood that Raz’s operations within an LSR are different from, and noncompatible with, communications between LSRs.

73. I understand that Petitioner also asserts that “[i]n either case, there is a desire to identify and assign a path that will have sufficient bandwidth to accommodate packets within a high-speed stream.” Pet. 15 (citing Ex.1004 ¶82). But, based on my review, this assertion is conclusory and unsupported, both in the Petition and the cited portion of Dr. Bhattacharjee’s declaration. Also, this assertion does not explain why a POSA would have sought to modify Raz’s particular teachings to include a LAG between LSRs. In fact, a POSA would have understood that Raz is premised on the notion that links between LSRs already exceed the capacity of internal processors. Raz at 1:40-51. That is, Raz describes a “problem” in which external link speeds “exceed the capacity” of existing internal processors, such that multiple internal processors are needed for a single high-speed link and thus Raz provides a “forwarding and provisioning mechanism that enables a high speed packet stream to be processed by multiple processors that operate at a slower rate tha[n] the inbound packet stream.” Raz at 1:40-2:3. A POSA would not have understood Raz to indicate any need for more bandwidth between LSRs.

74. It is my opinion that none of Petitioner’s arguments for limitation 1.0, including those assertions discussed above, establish *why* or *how* a POSA would have modified Raz so that it could be applied to communications between MPLS/LAG switches.

75. I understand that Petitioner relies on paragraph 82 of Dr. Bhattacharjee’s declaration. Pet. 15 (citing Ex.1004 ¶82). Based on my review, that paragraph of Dr. Bhattacharjee’s declaration contains conclusory assertions and, like the Petition, fails to explain specifically *why* or *how* Raz’s teachings would have been modified. Notably, in that paragraph of Dr. Bhattacharjee’s declaration, Dr. Bhattacharjee concedes that “Raz discusses the utilization of subports ... *within a LSR.*” Ex.1004 ¶82 (emphasis added).

76. Also, based on my review, Petitioner’s analysis for limitation 1.0 does not specifically address claim limitations 1.1–1.5, much less establish a motivation to modify Raz with respect to those limitations 1.1–1.5. Thus, to the extent that Petitioner relies upon its analysis of limitation 1.0 for purposes of limitations 1.1–1.5, it is my opinion that such reliance fails to establish a motivation for a POSA to modify Raz to meet those limitations 1.1–1.5.

77. **Limitation 1.1** — I understand that the Petition asserts the following regarding limitation 1.1: “a POSA would have understood that the method of Raz also could have been used for communicating packets from one MPLS/LAG switch

to another.” Pet. 19. But this assertion merely asserts a possibility of what Raz “could have been used for.” I have been informed that such a mere possibility (“could have”) is insufficient to establish a motivation to modify Raz. Regardless, this assertion does not explain why or how a POSA would have modified Raz’s teachings to apply to communicating packets between MPLS/LAG switches. Further, as explained in section VIII.B above, a POSA would not and could not have modified Raz’s teachings to apply to communications between network devices such as MPLS/LAG switches.

78. I understand that Petitioner also asserts again that “packet streams are communicated between routers and switches in *the same way* as they are communicated within a LSR.” Pet. 19 (emphasis added). As I discuss above, Petitioner made the same assertion for limitation 1.0 (Pet. 15), and as I explain above with respect to this assertion for limitation 1.0, this assertion is not true. In my opinion, a POSA would have known that communication of packets within a switch is different from communication of packets between switches, including for at least the “three technical reasons” I stated above with respect to this assertion. Also, a POSA would have understood that Raz itself distinguishes between operations within an LSR and between LSRs, and Raz makes clear that its invention is specifically directed to internal processing within an LSR. Raz at Abstract, Fig. 3, 1:40-59. Also, as discussed in section VIII.B above, a POSA would have understood

that Raz teaches, for example, that the outputs of its subports are aggregated/multiplexed into a single stream for transmitting between LSRs and that the same subport is used within both LSRs on respective sides of a link. Raz at Abstract, Figs. 1-3, 2:11-16, 2:47-48, 2:63-64, 6:24-27, 6:36-41, 7:20, 8:46-47, 14:19-22. A POSA would have understood that these two operations with an LSR are not, and cannot be, “the same as” communications between two LSRs, and the Petition does not and cannot explain how these two teachings regarding operations within an LSR are “the same as” communications between two LSRs, much less between two MPLS/LAG switches via a single physical tunnel port of the LAG. A POSA would have understood that Raz’s operations within an LSR are different from, and noncompatible with, communications between LSRs.

79. I understand that Petitioner also asserts that “[a] POSA would have known that the technique of [Raz] ... would also be effective to communicate the packet stream between MPLS/LAG switches” and that “Raz would have motivated a POSA to assign a physical tunnel port of the MPLS/LAG switch to a network tunnel.” Pet. 19-20. These assertions, however, assume the presence of a LAG between MPLS/LAG switches. As explained above (including in section VIII.B), a POSA would not have been motivated to modify or use Raz’s teachings for a LAG between MPLS/LAG switches, and these assertions here do not remedy that deficiency because these assertions here do not establish why a POSA would have

been motivated to use a LAG between Raz's LSRs to begin with. Also, the assertion here that Raz's technique would be effective for communicating via a LAG between two MPLS/LAG switches is conclusory, as it provides no explanation as to how a POSA would have purportedly modified the specifics of Raz's mechanism to apply Raz to such a LAG between MPLS/LAG switches. Further, as explained above (including in section VIII.B), Raz's teachings regarding operations within an LSR are not compatible with communications between LSRs, particularly via a LAG between LSRs. For example, Raz teaches that the outputs of its subports are aggregated into a single stream for transmitting between LSRs and that the same subport is used within both LSRs on respective sides of the link. Raz at Abstract, Figs. 1-3, 2:11-16, 2:47-48, 2:63-64, 6:24-27, 6:36-41, 7:20, 8:46-47, 14:19-22. These two aspects of Raz's mechanism are not compatible with or applicable to communications between two LSRs, and the Petition does not explain otherwise.

80. ***Limitations 1.2–1.5*** — I understand that the Petition asserts the following regarding limitations 1.2–1.5. For limitation 1.2, I understand that Petitioner asserts that a POSA would have taken Raz's disclosure of dedicating bits for a subport and extended that to dedicating bits for a physical port of a MPLS/LAG switch (Pet. 22). This assertion, however, does not establish why a POSA would have been motivated to modify Raz to use a LAG between LSRs to begin with. As

explained at least in section VIII.B above, a POSA would not have been motivated to apply Raz's teachings to a LAG.

81. For limitations 1.3–1.5, I understand that Petitioner asserts that “it would have been within the knowledge of a POSA” to (1.3) extend Raz's teachings to sending a label indicating a physical port of a LAG between MPLS/LAG switches to a preceding node, (1.4) treat packets received at a first MPLS/LAG switch the same way as packets received at Raz's LSR, and (1.5) “communicate packets from a first MPLS/LAG switch to a second MPLS/LAG switch ... in the same way as packets communicated from one LSR to another in Raz.” Pet. 23-25. **First**, it is my opinion that none of these assertions for limitations 1.3–1.5 discusses, much less establishes, a motivation for why a POSA would have modified Raz. **Second**, these assertions for limitations 1.3–1.5 are premised on an assumption that Raz includes two MPLS/LAG switches connected by a LAG. However, as explained above (including in section VIII.B), a POSA would not have been motivated to modify or use Raz's teachings for a LAG between MPLS/LAG switches, and these assertions here do not remedy that deficiency because these assertions here do not contain any analysis or reasoning for why a POSA would have been motivated to use a LAG between Raz's LSRs to begin with. Additionally, for limitation 1.5 in particular, it is my opinion that the Petition fails to discuss, much less establish, specifically why or how a POSA would have modified the existing teachings of Raz to meet all

aspects of that limitation, including that a data packet received by a first MPLS/LAG switch is sent from that switch to a second MPLS/LAG switch via a single physical tunnel of the LAG that is assigned by the first MPLS/LAG switch and indicated in a data packet label prepared by the first MPLS/LAG switch and included in the data packet received by the first MPLS/LAG switch. *See* '602 patent at claim 1. I further address the Petition's deficiency regarding limitation 1.5 in section VIII.E.2 below.

82. In sum, it is my opinion that the Petition fails to establish a motivation to modify Raz. Based on my review, the Petition does not explain specifically why or how a POSA would have modified the particular teachings of Raz to meet all limitations of the independent claims.

D. Petitioner Fails to Establish a Reasonable Expectation of Success

83. Based on my review of the Petition and evidence cited therein, the Petition does not contain persuasive argument or evidence that a POSA would have had a reasonable expectation of success for modifying Raz to meet the challenged claims.

84. I have been informed that obviousness requires that a POSA would have had a reasonable expectation of success in modifying the prior art to meet the claims and that this reasonable expectation of success is separate from the requisite motivation to modify the prior art.

85. Based on my review, it is my opinion that Petitioner does not present any argument, much less a persuasive argument, regarding whether a POSA would have had a reasonable expectation of success in modifying Raz to meet the claims. There is no mention of any “reasonable expectation of success” in either the Petition or Dr. Bhattacharjee’s declaration, except for Dr. Bhattacharjee’s discussion of the applicable law. Ex.1004 ¶14.

86. Indeed, in my opinion, a POSA would not have had a reasonable expectation of success of modifying Raz’s mechanism to meet the claims, as a POSA would not have even had a reasonable expectation of success of somehow applying Raz’s mechanism to communications between two network devices (such as the claimed MPLS/LAG switches) to begin with. As explained in sections VIII.B–C above, Raz’s mechanism involves several teachings that are incompatible with communications between network devices, and modifying of Raz to apply to such communications between network devices would render Raz inoperable or unsatisfactory for its intended purpose (i.e., its purpose of provisioning data across subports *within* a single network device).

E. Independent Claim 1

87. It is my opinion that Raz does not render obvious independent claim 1 of the ’602 patent.⁴ As explained in sections VIII.A–C above, Raz fails to render

⁴ The entirety of claim 1 is quoted in section VIII.A above.

obvious the challenged claims because Raz is fundamentally different from the claimed inventions of the '602 patent, a POSA would not have modified Raz to arrive at the '602 patent's claimed inventions (including claim 1), and Petitioner fails to establish either a motivation to modify or reasonable expectation of success. Further discussed below are several particular elements and limitations of claim 1 that Raz fails to teach or render obvious.

1. Raz Does Not Teach or Render Obvious a “LAG” Connecting a “first MPLS/LAG switch” to a “second MPLS/LAG switch”

88. Claim 1 recites a “LAG” (Link Aggregation Group) for communicating between a “first MPLS/LAG switch” and a “second MPLS/LAG switch,” and this is implicated in every limitation of claim 1 (i.e., limitations 1.1–1.5). For example, limitation 1.1 recites “a first MPLS/LAG switch” and “assigning ... a single physical tunnel port of a LAG”; limitation 1.2 recites the “first MPLS/LAG switch” and the “single physical tunnel port of the LAG”; limitation 1.3 recites the “MPLS/LAG switch” and the “single physical tunnel port”; limitation 1.4 recites the “first MPLS/LAG switch” and the “single physical tunnel port”; and limitation 1.5 recites “sending” a data packet “from said first MPLS/LAG switch to a second MPLS/LAG switch via said single physical tunnel port.”

89. The Petition relies on Raz's multiple subparts as allegedly constituting the claimed “LAG.” Pet. 15-17, 20-21, 23, 25. It is my opinion that

Raz's subports do not teach or render obvious the claimed "LAG" connecting a "first MPLS/LAG switch" to a "second MPLS/LAG switch" as recited in claim 1.

90. A POSA would have understood that Raz discloses that its subports are *within* a single LSR, not connecting two separate MPLS/LAG switches as claimed. *See* sections VIII.A–B *supra*. I understand that Petitioner and Dr. Bhattacharjee both admit that Raz's subports are "within" an LSR. Pet. 14-16; Ex.1004 ¶¶81-82. I further understand that despite Raz's subports being within an LSR, Petitioner nonetheless refers to Raz's subports as a "LAG." Pet. 15-17, 20-21, 23. For example, the Petition refers to: "subports in a LAG within a LSR"; "one subport of a LAG ... within a LSR"; "subport 3 of a LAG"; "[the] subport of [a] LAG." *Id.* But this is wrong, as a POSA would not have understood Raz's subports to constitute or suggest a LAG, for multiple independent reasons discussed below.

91. First, a POSA would have understood a LAG to be a group of network connections, or *links*, that are *between* network components. For example, the '602 patent explains that a LAG involves a group of parallel "links between two endpoints in a data network," and Ferguson (Ex. 2007, "Ferguson"), which is one of Petitioner's own asserted references, likewise explains that "link aggregation" involves multiple interconnects "between ... two devices." '602 patent at 2:1-5; Ferguson at 1:28-42. Also, for example, Raz itself refers to the connections

between LSRs as “links,” such as 10 GE link 60 between LSR A and LSR B and 10 GE link 68 between LSR B to LSR C as depicted in Figure 3, as well as external 10G links 28 and 48 depicted in Figures 1 and 2, respectively. *See* Raz at Figs. 1-3, 6:67-7:5, 8:33-39, 9:39-40, Abstract (“The output of all the subports is ... combined into a single high speed packet stream and transmitted over the link.”), 6:34-38, 7:17-26, 7:39-42, 8:46-53. But, as explained above, including in sections VIII.A–B, Raz’s subports are *within* a single LSR, not links *between* LSRs. Indeed, a POSA would have understood that Raz’s subports are internal network processors, not links between two endpoints of a network. Raz at 1:40-59, 2:1-2, 2:5-6 (“a network processor or FPGA is used to implement the subport”), 6:25-29, 7:42-45 (“forwards the packet to subport 3 for packet processing”), 7:59-64, 10:22-23 (“subport network-processors”), Fig. 6 and 12:66-13:5 (referring to subports 128 and 130 as “network processors”). For example, Raz describes implementing its subports as “network processors” or “an FPGA” that can “perform the [required] packet processing.” Raz at 7:59-64. Thus, in my opinion, a POSA would not have understood Raz’s subports to constitute or suggest a LAG.

92. Second, a POSA would have understood that Raz’s multiple subports are not “aggregated” in the sense of a LAG. A POSA would have understood “aggregated” in the sense of a LAG, for example, to be according to the IEEE

802.3ad link aggregation standard⁵ referenced in the '602 patent. '602 patent at 2:1-17, 3:64-4:1. Ferguson similarly references this IEEE 803.ad standard for “link aggregation.” Ferguson at 1:28-32. The IEEE 802.3ad link aggregation standard states, in part:

Link Aggregation allows one or more links to be aggregated together to form a [LAG], such that a MAC Client can treat the [LAG] as if it were a single link. To this end, it specifies the establishment of DTE to DTE logical links, consisting of N parallel instances of full duplex point-to-point links operating at the same data rate.

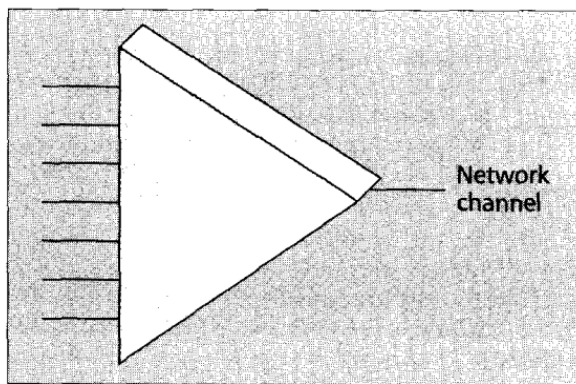
Ex.2012 at Abstract. A POSA would have understood that “aggregated” in the sense of a LAG, as described in IEEE 802.3ad, differs from Raz because Raz says to “aggregate” the *output* of its multiple subports into a single high-speed packet stream, which a POSA would have understood to merely disclose multiplexing.

Raz at Abstract, 6:36-38, 14:19-22, 1:1-8, 1:65-66; *see* Ex.2009 at 473; Ex.2010 at

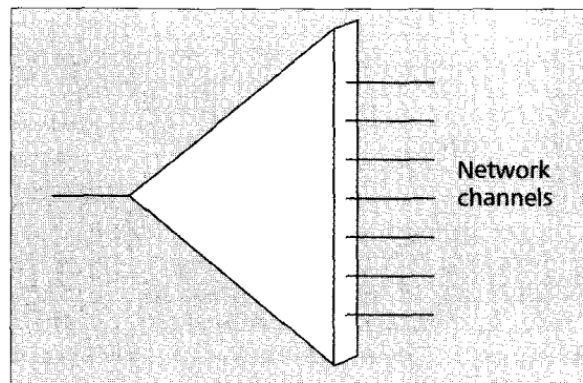
⁵ In my opinion, the IEEE 802.3ad LAG standard also reinforces the first point above that a LAG involves links *between* network devices and is different from, and unrelated to, internal device components such as Raz’s subports. A POSA would have understood that the IEEE 802.3ad standard is concerned with Ethernet links between switches and that using the term LAG to refer to Raz’s subports within a switch is invalid. First, as explained above in section VIII.C, there are no Ethernet links (or, more generally, communication links) within a switch. Second, no Ethernet frames exist or are communicated within a switch. As soon as an Ethernet frame is received by a switch, the MPLS packet it contains is extracted and stored and the Ethernet frame header and trailer are discarded after processing. Consequently, the Ethernet standards, including the IEEE 802.3ad link aggregation standard, are not applicable within a switch. Therefore, a POSA would have understood that Raz’s subports within an LSR or switch could not constitute a LAG as defined in the IEEE 802.3ad standard or used in the '602 patent.

43, Fig. 1; Ex.2011. A POSA would have understood that multiplexing was an operation that was common when multiple low-speed streams are combined for transmission over a single high-speed link, as in Raz. Ex.2009 at 473 (describing how “conventional multiplexing combines various independent low-speed channels from different sources into one high-speed link for ... transmission”); Ex.2010 at 43, Fig. 1. In my opinion, a POSA would have understood that Raz’s combining or multiplexing of subport streams into a single stream is the *opposite* of aggregating multiple parallel links into a group to form a LAG (*inverse* multiplexing) because with multiplexing, a single high-speed link is used to transmit packets from multiple low-speed tributary streams, whereas with link aggregation (inverse multiplexing), packets from a high-speed stream are spread across multiple low-speed links for transmission. See Raz at 1:1-8, 1:65-66, Abstract, 2:11-13, 2:47-48, 2:63-64, 6:36-38, 14:19-22; ’602 patent at 2:1-5; Ferguson at 1:28-42; Ex.2011 (“While multiplexing combines multiple signals into a single signal, [inverse multiplexing] divides a data stream into multiple concurrent streams that are transmitted at the same time across separate channels”); Ex.2009 at Abstract, 473 (“Inverse Multiplex[ing] is the reverse of multiplexing, because it involves breaking a ... signal into a number of smaller and independent low-cost channels for transmission”); Ex.2010 at 43 (explaining that “multiplexing involves the aggregation of several independent channels into a

high-data-rate network channel,” whereas “channel aggregation [i.e., inverse multiplexing] ... is the process of implementing a high-speed channel by splitting it into several network channels at lower speeds”), Figs. 1-2. Exhibit 2010 illustrates the fact that Raz’s multiplexing of subport outputs into a single stream for transmission across a single network link, as depicted below in Figure 1 of Exhibit 2010, is the opposite of inverse multiplexing, such as the claimed LAG, which contains multiple parallel network links, as depicted below in Figure 2 of Exhibit 2010.



■ Figure 1. *Multiplexer symbol.*



■ Figure 2. *Inverse multiplexer.*

Ex.2010 at Figs. 1-2.

93. Third, Raz actually references a “LAG (Link Aggregation Group)” in one place in Raz’s specification. Raz at 9:9-15. A POSA would have understood this to demonstrate that Raz distinguishes between a LAG and its own subports. Indeed, the portion of Raz that references a LAG does so to explain how to *repurpose* a commercially-available LAG-related switch to implement Raz’s subports within an LSR, stating: “*For example, some commercially available layer*

2 switches can determine the destination port for a packet destined to a LAG This can be used for spreading the packets to the subports by using the layer-2 switch as the port-forwarding module” Raz at 9:9-15. Notably, this portion of Raz describes using the commercially-available LAG-related switch to send packets to subports within an LSR, not to send packets between two LSRs via a LAG. *Id.* Based on this disclosure in Raz, a POSA would have understood that Raz’s subports are not the same as a LAG.

94. Moreover, as discussed above, a POSA would have understood that Raz teaches to combine (i.e., multiplex) the output of its subports into a *single* high-speed packet stream before transmitting that data to another LSR, and in my opinion, a POSA would have understood this to teach away from using a LAG—i.e., a form of *inverse* multiplexing that uses *multiple* streams—between Raz’s LSRs. Raz at 1:1-8, 1:65-66, Abstract, 2:11-13, 2:47-48, 2:63-64, 6:24-27, 6:36-38, 14:19-22; *see* Ex.2011; (explaining how multiplexing, such as in Raz, and inverse multiplexing, such as a LAG, are opposites); Ex.2009 at Abstract, 473 (same); Ex.2010 at 43, Figs. 1-2 (same).

**2. Raz Does Not Teach or Render Obvious Limitation 1.5:
“sending said data packet from said first MPLS/LAG switch to
a second MPLS/LAG switch via said single physical tunnel
port”**

95. Claim limitation 1.5 recites “sending said data packet from said first MPLS/LAG switch to a second MSPLS/LAG switch via said single physical

tunnel port having the port serial number encoded in the data packet label.” It is my opinion that Raz does not teach or render obvious this limitation, including because Raz does not teach limitation 1.5, Petitioner fails to establish that Raz renders obvious limitation 1.5, and even if Raz were modified as Petitioner asserts, it still does not render obvious limitation 1.5.

a. Raz Does Not Teach Limitation 1.5

96. It is my opinion that Raz does not teach limitation 1.5.

97. Based on my review, I understand that the Petition points to a single example in Raz as allegedly disclosing this limitation, arguing as follows:

Raz discloses [limitation 1.5]. ... For example, LSR B in the example described in Column 7 of Raz is the LSR that generates the data packet label in which the port serial number (e.g., subport 3) is encoded, and it corresponds to the claimed first MPLS/LAG switch. ... A POSA would have understood that the data packet in LSR B could be sent to another LSR (which would correspond to the claimed second MPLS/LAG switch) via a physical tunnel subport (subport 3) having the port serial number encoded in the data packet label.

Pet. 25 (discussing Raz at 7:30-45). In this example from Raz relied upon by the Petition, a POSA would have understood that Raz discloses that an LSR B decides to accept data over subport 3 and sends to LSR A a label indicating subport 3 such that a data packet sent from LSR A to LSR B is processed by LSR A’s output subport 3 and LSR B’s input subport 3. Raz at 7:30-45.

98. First, however, as I explain in section VIII.E.1 above, Raz’s subports do not teach or render obvious the claimed “LAG.” Thus, Raz’s subport, such as

subport 3 in the relied-upon example for limitation 1.5, is not a “single physical tunnel port [*of a LAG*],” as recited in limitation 1.5.

99. Second, limitation 1.5 recites “sending said data packet from said first MPLS/LAG switch to a second MSPLS/LAG switch via said single physical tunnel port.” That is, limitation 1.5 recites sending the data packet via the assigned physical tunnel port of the LAG *between* the first and second MPLS/LAG switches. As explained in sections VIII.A–B above, however, a POSA would have understood that Raz’s subports are clearly *within* the LSR. Indeed, I understand that Petitioner and Dr. Bhattacharjee both admit that Raz’s subports are “within” an LSR. Pet. 14-16; Ex.1004 ¶¶81-82. Therefore, in the example of Raz relied upon by Petitioner for limitation 1.5, a POSA would have understood that subport 3 is *within* LSR B, and thus that subport 3 cannot be the claimed “single physical tunnel port” “via” which the data packet is sent “from said first MPLS/LAG switch to a second MSPLS/LAG switch,” as recited in limitation 1.5.

100. Third, in the example of Raz relied upon by Petitioner for limitation 1.5, a POSA would have understood that LSR B does not use subport 3 to *send* data but rather to *receive* data. That is, a POSA would have understood that Raz teaches that “LSR B decides to *accept* the LSP on subport 3,” and “[w]hen a packet for the provisioned LSP is *received over a link connected to LSR A*, it is forwarded ... out over the 10G link *to LSR B* with the previously assigned label indicating subport 3,”

such that “[t]he port forwarding module in LSR B ... forwards the packet to subport 3 *for packet processing*.” Raz at 7:30-45. Indeed, Raz instructs the POSA to “[n]ote that ... the downstream (i.e. receiving) node,” i.e., LSR B in the relied-upon example, “determines the subport it wants to *receive* the LSP on,” which means that in the relied-upon example, LSR B selects and uses subport 3 for *receiving* data. Raz at 7:26-29. Thus, because the example relied upon by Petitioner for limitation 1.5 involves LSR B receiving, not sending, the data packet via subport 3, Petitioner is wrong in asserting that the data packet would be sent from LSR B “to another LSR (which would correspond to the claimed second MPLS/LAG switch) via [subport 3].” Pet. 25.

101. Based on my review, Petitioner’s position for limitation 1.5 is based on a mischaracterization of the term “forward[]” in Raz. For limitation 1.5, Dr. Bhattacharjee’s declaration appears to rely on Raz’s disclosure that a receiving LSR “forwards” the received data packet to a subport. *See* Ex.1004 ¶107. First, Dr. Bhattacharjee quotes the following portion of Raz, which comes from the example in Raz that the Petition relies upon for limitation 1.5: “The port forwarding module in LSR B examines the label in the received packet and in response thereto **forwards** the packet to Subport 3 for packet processing.” Ex.1004 ¶107 (emphasis added) (quoting Raz at 7:42-45). Dr. Bhattacharjee then quotes the following portion of Raz, which is a clause from Raz’s claim 1: “**forwarding** inbound packets transmitted

by said upstream node and received over said communications link by said downstream node to a subport in accordance with the label associated with said inbound packet.” Ex.1004 ¶107 (emphasis added) (quoting Raz at 14:23-26). Importantly, however, both of these passages quoted by Dr. Bhattacharjee refer to a receiving LSR forwarding the received data packet to a subport *within* that same receiving LSR for input packet processing, not forwarding the data packet *via* the subport to some *subsequent* LSR. For example, Raz similarly uses the term “forward” in describing Raz’s Figure 3 shown below, disclosing that “[a]t LSR B, the layer 2 switch **forwards** the packet to subport 0.” Raz at Fig. 3, 9:59-10:4. As a POSA would have understood, though, this “forward[ing]” by LSR B does not mean that LSR B sends the packet to LSR C via that subport 0. Raz at Fig. 3, 9:59-10:4. Rather, as a POSA would have understood, this “forward[ing]” means that LSR B sends the packet to subport 0 *within* LSR B, and LSR B actually uses a different subport (subport 1) when sending the packet to LSR C. Raz at Fig. 3, 9:59-10:4.

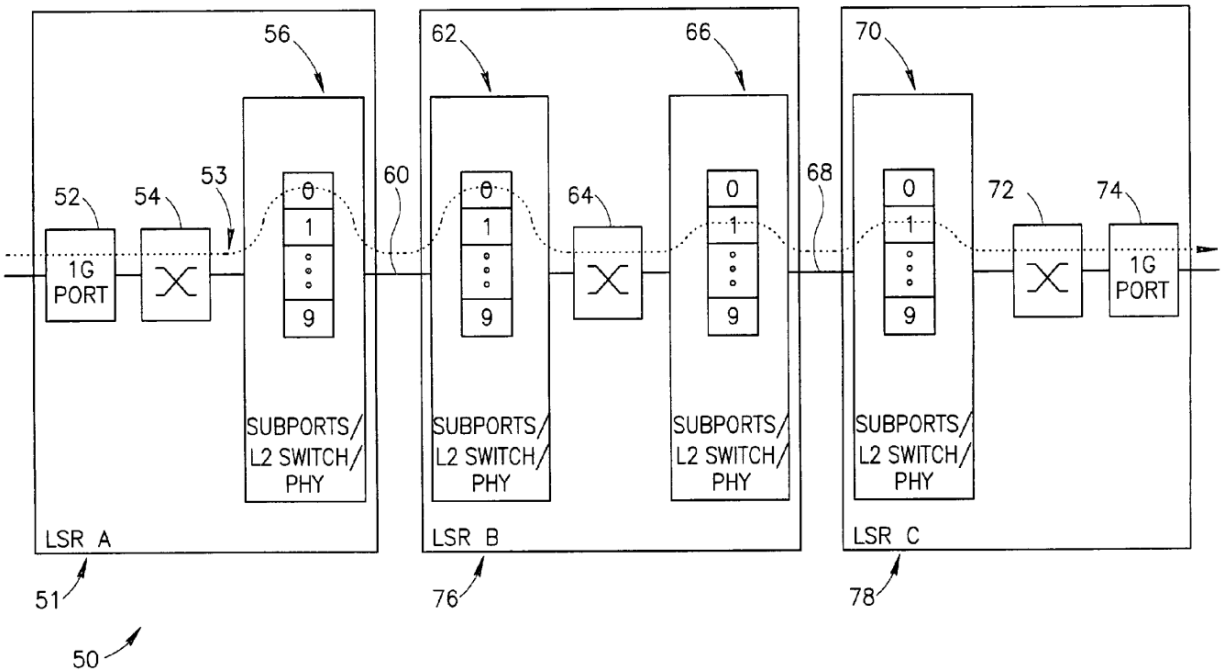


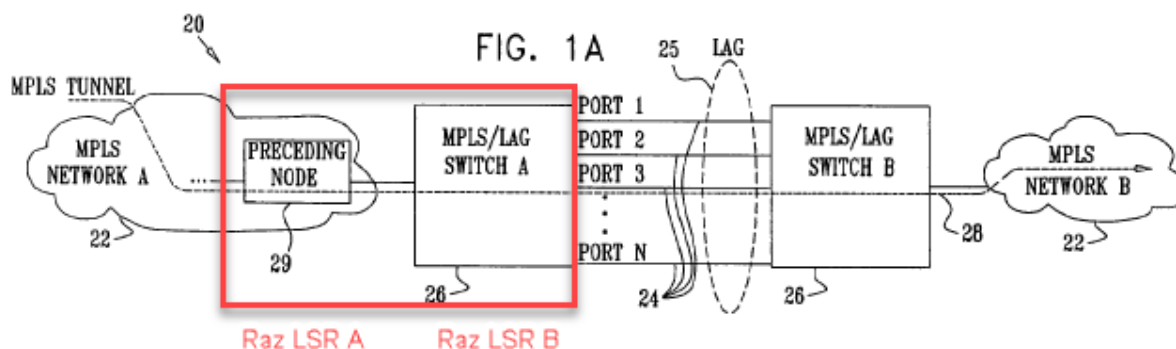
FIG.3

Raz at Fig. 3. Indeed, Raz teaches that a receiving LSR selects only the subport used for *receiving* data packets at the given LSR, and whatever subport is used for transmitting data packets to the next LSR is independently chosen by that next LSR. Raz at 7:17-45, 8:44-55, 9:29-10:4, 2:18-20, 6:43-45. Thus, regarding the two passages of Raz that are quoted by Dr. Bhattacharjee about a receiving LSR “forwarding” data packets to a subport (Raz at 7:42-45, 14:23-26), a POSA would have understood that these two quoted passages are completely unrelated to sending data packets from a first MPLS/LAG switch to a second MPLS/LAG switch as recited in limitation 1.5. Moreover, a POSA would have understood these two quoted passages to reinforce the fact that Raz relates to provisioning subports *within*

an LSR, as the term “forward[]” in each passage refers to a receiving LSR forwarding an inbound data packet to a subport within that receiving LSR.

102. Fourth, I understand that despite Petitioner arguing that Raz “discloses” limitation 1.5, Petitioner’s argument relies on what “could” happen, not on what Raz actually discloses. Pet. 25 (asserting that “the data packet in LSR B *could be* sent to another LSR ... via [subport 3]” (emphasis added)). Thus, I understand the Petition to admit that Raz does not actually *disclose* limitation 1.5 as Petitioner asserts.

103. Indeed, a POSA would have understood that the example in Raz that Petitioner relies upon for limitation 1.5 does not include any discussion as to what happens to a data packet downstream of LSR B. This is illustrated by the annotated version below of Figure 1 of the ’602 patent. This annotated figure associates LSR A and LSR B from the relied-upon example in Raz with the depicted preceding node and first MPLS/LAG switch, respectively, which is in accordance with Petitioner’s argument for limitation 1.5. See Pet. 25 (“LSR B in the example described in Column 7 of Raz ... corresponds to the claimed first MPLS/LAG switch.”).



'602 patent at Fig. 1 (annotated). As this annotated figure demonstrates, the relied-upon example in Raz is completely unrelated to communicating a data packet between the claimed first and second MPLS/LAG switches as recited in limitation 1.5. A POSA would have understood that the relied-upon example says nothing about how Raz (or even a modified version of Raz) would handle data packets *after* they leave LSR B, which Petitioner associates with the claimed “first MPLS/LAG switch.” That is because Raz teaches that in a given pair of sending/receiving LSRs, the receiving LSR (i.e., LSR B in the relied-upon example) determines only the subport it uses for receiving a data packet, not sending the data packet, as the subport used for the next hop to the next downstream LSR is chosen independently by that next LSR. Raz at 7:26-27, 7:21-22, 8:52-54, 8:47-48, 2:18-20, 6:43-45.

b. Petitioner Fails to Establish that Raz Renders Obvious Limitation 1.5

104. Based on my review of the Petition and evidence cited therein, the Petition fails to establish that Raz render obvious claim limitation 1.5. It is my opinion that the Petition does not establish that a POSA would have modified Raz to meet limitation 1.5, as the obviousness arguments for limitation 1.5 are conclusory and the Petition fails to identify and explain specifically why or how a POSA would have modified Raz to arrive at this claim limitation.

105. I understand that the Petition first asserts that “[a] POSA would have understood that the data packet in LSR B could be sent to another LSR (which

would correspond to the second MPLS/LAG switch) via a physical tunnel subport (subport 3) having the port serial number encoded in the data packet label.” Pet. 25 (citing Raz at 7:17-29, 7:39-45, 9:29-58, 14:23-26, Figs. 3-4; Ex.1004 ¶107). But the Petition provides no analysis or explanation for this assertion. And a POSA would have understood that none of passages that Petitioner cites from Raz say anything about what would happen to a data packet *after* it leaves the subject LSR (i.e., LSR B in the relied-upon example in column 7 of Raz), let alone which port the data would travel on in a subsequent hop. Certainly, none of the cited passages suggest that the packet would be sent to a “second MPLS/LAG switch” on subport 3, as Petitioner asserts. Further, Petitioner’s assertion is wrong for the reasons explained in section VIII.A above, including that subport 3 is *within* LSR B and that LSR B uses subport 3 for *receiving*, not *sending*, data packets. In fact, a POSA would have understood that Raz teaches that if, as Petitioner alleges, the data packet is sent from LSR B “to another LSR (which would correspond to the claimed second MPLS/LAG switch)” (Pet. 25), then whatever subport is used by LSR B for processing the data packet for transmission to that next downstream LSR would be independently chosen by that next LSR. Raz at 7:17-29, 8:44-55, 9:29-10:4, 2:18-20, 6:43-45. That is, as a POSA would have understood, Raz teaches that in a given pair of sending/receiving LSRs, the receiving LSR (i.e., LSR B in Petitioner’s assertion above) determines only the subport it uses for

receiving a data packet, not sending the data packet, as the subport used for the next hop to the next downstream LSR is chosen independently by that next LSR. Raz at 7:26-27, 7:21-22, 8:52-54, 8:47-48, 2:18-20, 6:43-45. Moreover, the expert testimony that Petitioner relies on for the above assertion (i.e., Ex.1004 ¶107) quotes Raz at 7:42-45 and 14:23-26, which a POSA would have understood are unrelated to transmitting data between LSRs and instead simply reinforce Raz's teachings of provisioning subports *within* an LSR for processing packets transmitted between LSRs, as explained in sections VIII.A–B above.

106. I understand that the Petition next and lastly asserts that “it would have been within the knowledge of a POSA to communicate packets from a first MPLS/LAG switch to a second MPLS/LAG switch in a MPLS network *in the same way as packets communicated from one LSR to another in Raz.*” Pet. 25. But as explained above in sections VIII.A–B and VIII.E.1, a POSA would have understood that the way that Raz teaches transmitting packets between LSRs is via a single high-speed link and not, as recited in limitation 1.5, “via [a] single physical tunnel port [of a LAG].” See Raz at Abstract, Figs. 1-3. Also, in the corresponding portion of Dr. Bhattacharjee's declaration, the only mention of a “second MPLS/LAG switch” is for that same assertion, i.e., regarding communicating packets between MPLS/LAG switches “in the same way as packets [are] communicated from one LSR to another in Raz.” Ex.1004 ¶108.

Again, a POSA would have understood that the way that Raz communicates packets between LSRs, as Dr. Bhattacharjee relies upon, is via a single link, which does not meet limitation 1.5.

107. Also, it is my opinion that the Petition fails to analyze specifically *how* or *why* Raz would purportedly be modified to transmit packets from a first MPLS/LAG switch to a second MPLS/LAG switch in any way, let alone in the claimed manner of limitation 1.5 and its related limitations (e.g., other limitations that recite the “first MPLS/LAG switch” recited in limitation 1.5). Pet. 24-25. That claimed manner more specifically comprises sending a data packet from a first MPLS/LAG switch to a second MPLS/LAG switch via a single physical tunnel port of a LAG that is assigned by the first MPLS/LAG switch and is identified in a data packet label that is generated by the first MPLS/LAG switch, sent to a preceding node, and included in a data packet received by the first MPLS/LAG switch from the preceding node.

108. Based on my review, I understand that the Petition does not use the word “modify” a single time for limitation 1.5 (Pet. 24-25), and it is my opinion that the Petition does not address how Raz would be modified to overcome its deficiency regarding limitation 1.5, as explained in section VIII.E.2.a above. It is also my opinion that the Petition fails to discuss or mention how a POSA would purportedly have had a “reasonable expectation of success” for any such

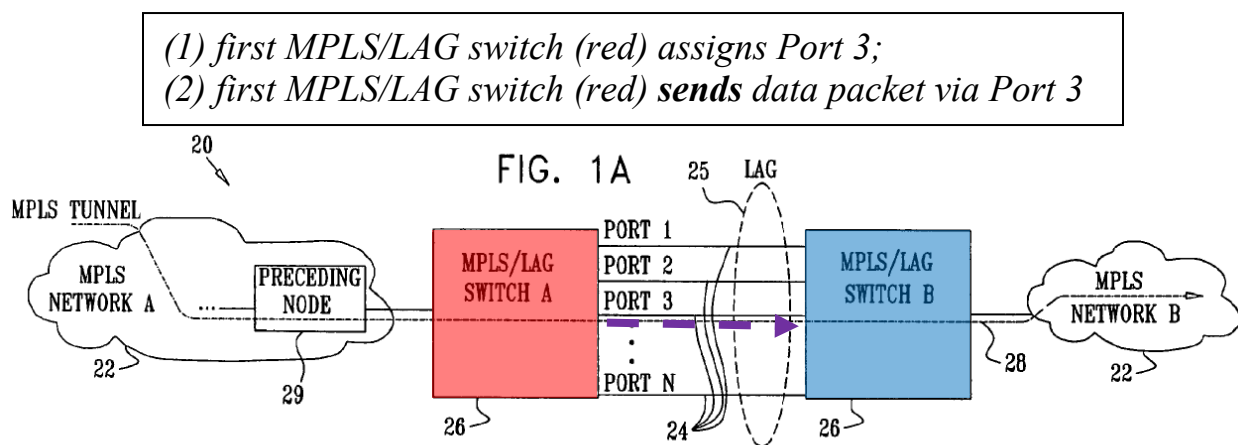
modification. Pet. 24-25. Similarly, Dr. Bhattacharjee’s declaration also does not discuss how or why Raz would be modified, or any reasonable expectation of success, with respect to limitation 1.5. Ex.1004 ¶¶106-109. It is my opinion that the alleged motivations provided by Petitioner are generic and do not specifically address the teachings of Raz or aspects of limitation 1.5 and its related limitations (e.g., other limitations that recite the “first MPLS/LAG switch” that is recited in limitation 1.5). *See* Pet. 19-20, 22, 24-25.

c. Even if Modified as Petitioner Asserts, Raz Does Not Render Obvious Limitation 1.5

109. It is my opinion that even if a POSA would have modified Raz as Petitioner asserts, this would nonetheless fail to render obvious limitation 1.5. That is, even if a POSA had been motivated to, and had the capability to, apply Raz’s forwarding and provisioning mechanism to communications between two LSRs as Petitioners asserts (Pet. 15, 19-20, 25), such modification would still not meet claim 1, including limitation 1.5.

110. Limitation 1.5 recites that the “first MPLS/LAG switch”—which assigns the “single physical tunnel port” per limitation 1.1 and prepares the “data packet label” per limitation 1.2—then *sends* the data packet “to a second MSPLS/LAG switch via said single physical tunnel port.” Below is an annotated version of the ’602 patent’s Figure 1A that illustrates this claim language. This annotated figure demonstrates how the claimed “first MPLS/LAG switch” (red)

assigns a “single physical tunnel port” (here, exemplary Port 3) per limitation 1.1 and then **sends** a data packet via that assigned Port 3 (dashed purple line) to the “second MPLS/LAG switch” (blue).



’602 patent at Fig. 1A (annotated).

111. A POSA would have understood that Raz, however, teaches that the LSR that assigns a subport and generates the label (i.e., the alleged “first MPLS/LAG switch”) does not then **send** a data packet via that assigned subport to a downstream LSR but instead **receives** the data packet using the assigned subport. Raz at 7:26-29, 8:52-55, 7:30-45, 9:41-10:4. A POSA would have understood this because, in Raz, “it is the downstream (i.e. receiving) node that determines the subport it wants to receive the LSP on.” Raz at 7:26-29. That is, a POSA would have understood Raz to teach that after a packet is received by a given LSR, the subport used for the next hop is not chosen by that given LSR but instead by the

next downstream LSR. Raz at 2:18-20 (“The subports used on both sides of the next hop, however, are independent.”), 6:43-45, 7:17-29, 8:44-55, 9:41-10:4.

112. Below is an annotated version of Raz’s Figure 3 that demonstrates these teachings in Raz. This annotated figure depicts what Petitioner refers to as the “second example” discussed in the block quote that Petitioner relies on for limitation 1.2, in which Petitioner asserts that “LSR B ... corresponds to the [claimed] first MPLS/LAG switch.” Pet. 20-22. As shown by this annotated figure, Raz teaches that this LSR B (red) selects subport 0 and then *receives* a data packet using that assigned subport 0 (dashed purple line). Raz at 9:51-65. But Raz does not teach that LSR B *sends* the data packet downstream to LSR C via subport 0, as Raz instead teaches that LSR C independently selects which subport is used for data sent from LSR B to LSR C. Raz at 9:41-51, 9:65-10:4.

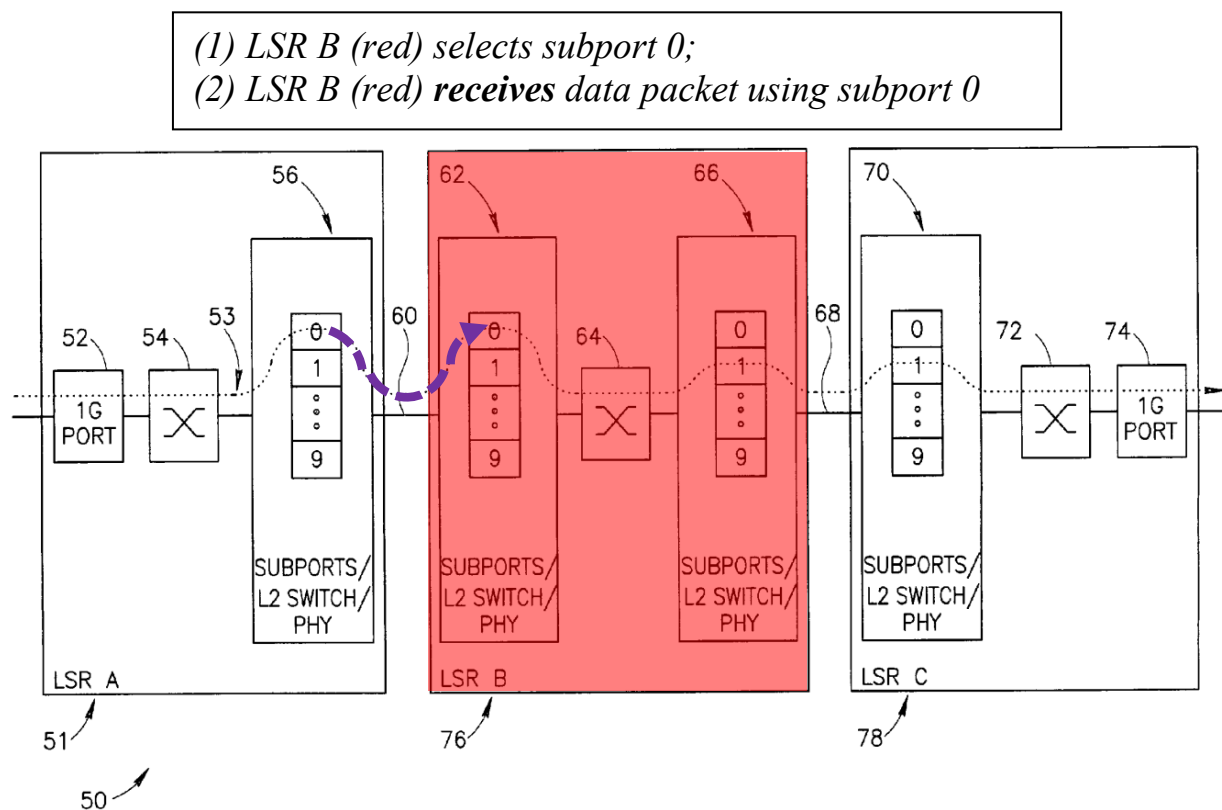


FIG.3

Raz at Fig. 3 (annotated), 9:29-10:4.

113. A POSA would have understood that these teachings of Raz are further demonstrated by the example in column 7 of Raz that Petitioner relies upon for limitations 1.1 and 1.3-1.5. Pet. 17, 23-25. In that example in column 7, Raz considers an example with LSR A and LSR B, for which Petitioner asserts that “LSR B ... corresponds to the claimed first MPLS/LAG switch” (Pet. 25). A POSA would have understood this example in Raz as disclosing that LSR B selects subport 3, generates a label indicating subport 3, and then **receives** a packet from LSR A that is processed by LSR A’s output subport 3 and LSR B’s subport 3. Raz

at 7:30-45. A POSA would have understood that this example in Raz does not disclose that LSR B uses the assigned subport 3 to *send* the data packet to a downstream node.

114. It is therefore my opinion that, even if a POSA had been motivated and capable of somehow modifying Raz to apply to communications between two MPLS/LAG switches as Petitioner asserts, such modification would still fail to meet claim 1 and limitation 1.5 in particular. That is, even if Raz’s forwarding and provisioning mechanism were somehow implemented with respect to a LAG between two MPLS/LAG switches such that a first MPLS/LAG switch assigns a “single physical tunnel port” of the LAG and prepares a corresponding “data packet label” according to limitations 1.1-1.2, then a POSA would have understood that under Raz’s mechanism, that first MPLS/LAG switch would *receive* a data packet via that assigned “single physical tunnel port,” not *send* the data packet as recited in limitation 1.5.

F. Independent Claim 15

115. It is my opinion that Raz does not render obvious independent claim 15 of the ’602 patent.⁶ As explained in sections VIII.A–C above, Raz fails to render obvious the challenged claims because Raz is fundamentally different from the claimed inventions of the ’602 patent, a POSA would not have modified Raz to

⁶ The entirety of claim 15 is quoted in section VIII.A above.

arrive at the '602 patent's claimed inventions (including claim 15), and Petitioner fails to establish either a motivation to modify or reasonable expectation of success. Further discussed below are several particular reasons why Raz does not render obvious claim 15.

1. Raz Does Not Teach or Render Obvious a “LAG” Connected to a “second MPLS/LAG switch”

116. As explained in section VIII.E.1 above, it is my opinion that Raz's subports do not teach or render obvious a “LAG” connected to a “first MPLS/LAG switch” to a “second MPLS/LAG switch.”

117. Similar to claim 1, claim 15 recites a “LAG” (Link Aggregation Group) for communicating to a “second MPLS/LAG switch,” and this is implicated in multiple limitations of claim 15. For example, limitation 15.2 recites a “single physical tunnel port of a LAG”; limitation 15.3 recites the “single physical tunnel port of the LAG”; and limitation 15.8 recites to “send” a data packet “to the second MPLS/LAG switch via said single physical tunnel port.”

118. Also, as the Petition did for claim 1, the Petition again relies on Raz's multiple subports as allegedly constituting the “LAG” for claim 15. Pet. 43-44.

119. Thus, it is my opinion that section VIII.E.1 above is also applicable regarding claim 15 and that for the same reasons explained in that section, Raz's subports do not teach or render obvious the claimed “LAG” connected to a “second MPLS/LAG switch” as recited in claim 15. Petitioner's obviousness argument

regarding claim 15 therefore fails for the same reasons discussed in section VIII.E.1 above.

2. Raz Does Not Teach or Render Obvious Limitations 15.5–15.8 Regarding a “mapper”

120. The combination of limitations 15.5–15.8 recites:

[15.5] a mapper, which is configured to:

[15.6] receive a data packet from an upstream node;

[15.7] detect said data packet label in said data packet; and

[15.8] if said data packet contains said data packet label, send said data packet to the second MPLS/LAG switch via said single physical tunnel port.”

121. The Petition asserts that Raz’s forwarding module constitutes the claimed “mapper.” Pet. 46 (“Raz teaches a forwarding module that performs [the functions of limitations 15.6–15.8] and thus corresponds to the mapper recited in [limitation 15.5].”) (citing Raz at 7:30-58 regarding a “port forwarding module”).

122. It is my opinion that the Petition fails to establish that Raz teaches or renders obvious limitations 15.5–15.8 for multiple reasons, discussed below.

123. **First** — Based on my review, despite the Petition relying upon Raz’s subport forwarding module as the claimed “mapper” (Pet. 46), the Petition does not explain if or how Raz’s subport forwarding module is purportedly configured to perform the functions recited in limitations 15.6–15.8. I understand that Petitioner does not mention Raz’s subport forwarding module in its analyses of limitations 15.6–15.8, nor in its analyses of limitations 1.3 and 1.4 relied upon

therein. Pet. 46-48, 22-24. I further understand that the entire Petition mentions Raz's subport forwarding module only twice: once for limitation 15.5 and once in an overview section regarding Raz. Pet. 9, 46. It is my opinion that Petitioner's analyses of limitations 15.6–15.8 thus fail to sufficiently explain how Raz's subport forwarding module meets those limitations.

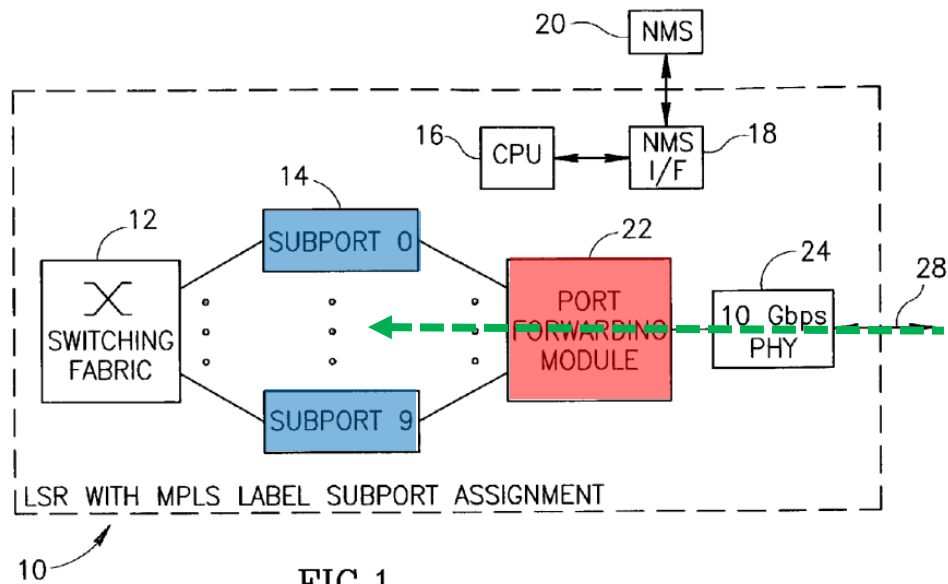
124. ***Second*** — Regardless of Petitioner's analyses, it is my opinion that Raz's subport forwarding module does not to meet the combination of limitations 15.5–15.8 and thus cannot constitute the claimed “mapper” as Petitioner asserts.

125. A POSA would have understood that Raz's [subport] forwarding module, which Petitioner relies upon as the claimed “mapper,” is taught in different embodiments as the following: (i) port forwarding module 22 shown in Figure 1, which is also discussed in the example disclosed in column 7, and (ii) subport forwarding modules 132 and 126 shown in Figure 6. Raz at Fig. 1, 6:65-7:5, 7:30-52, Fig. 6, 12:61-13:5.

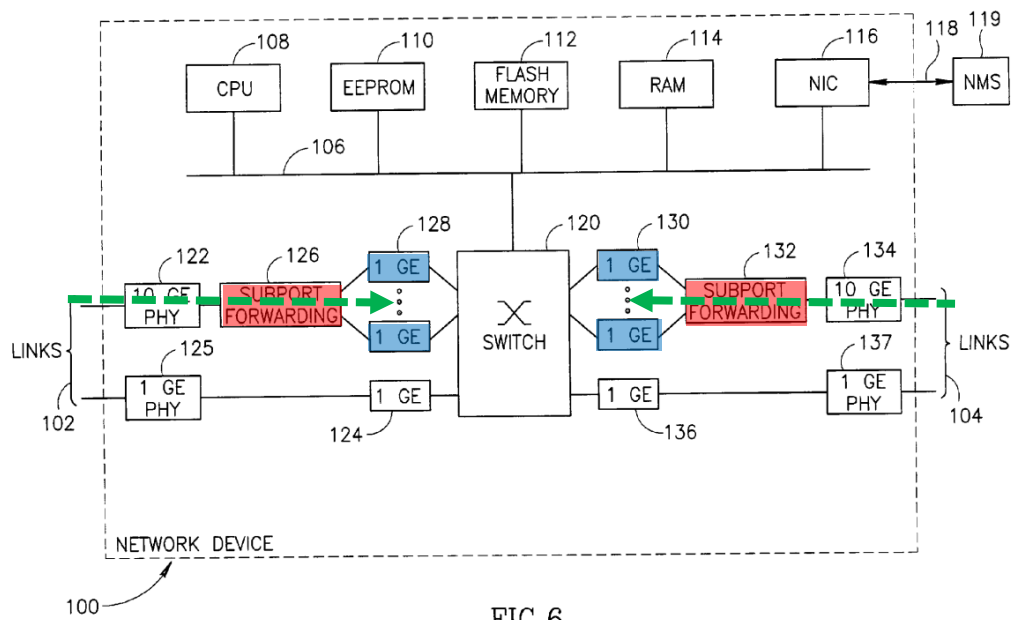
126. I note that Petitioner also cites Raz's Figure 3 and corresponding disclosure at 9:29-58 as purportedly relating to Raz's subport forwarding module. Pet. 46. However, a POSA would have understood that Raz does not disclose a specific subport forwarding module in that embodiment of Figure 3 described at 9:29-58. Based on my review, Petitioner appears to rely on “modules” 56, 62, 66, and 70 in that embodiment of Figure 3, but a POSA would have understood that

those “modules” each comprise subports, a layer 2 switch, and a PHY and are thus different from Raz’s subport forwarding module, as disclosed in the embodiments of Figures 1 and 6. Raz at Fig. 3, 9:29-40; *see also* Raz at Fig. 1, 6:65-7:5, 7:30-52, Fig. 6, 12:61-13:5. Regardless, it is my opinion that the embodiment of Raz’s Figure 3 described at 9:29-58 and the “modules” thereof do not and cannot rectify Raz’s failure to render obvious limitations 15.5–15.8 regarding the claimed “mapper.”

127. A POSA would have understood that, on one hand, Raz teaches that if its subport forwarding module “receive[s] a data packet from an upstream node” as recited in limitation 15.6, then the subport forwarding module does not send the packet to a subsequent different LSR as required by limitation 15.8. A POSA would have understood that, instead, the subport forwarding module just directs such a received data packet to a subport within the LSR for processing. *See* Raz at Fig. 1, Fig. 6, 3:28-32, 7:42-45, 7:49-52, 12:66-12:1, 13:22-24, 16:43-53. This teaching is demonstrated by the following annotated versions of Raz’s Figures 1 and 6 below. These annotated figures both show how an inbound packet (green dashed line) received in a given LSR by the subport forwarding module (red) is directed to a subport (blue), not sent to a different LSR as required by limitation 15.8.



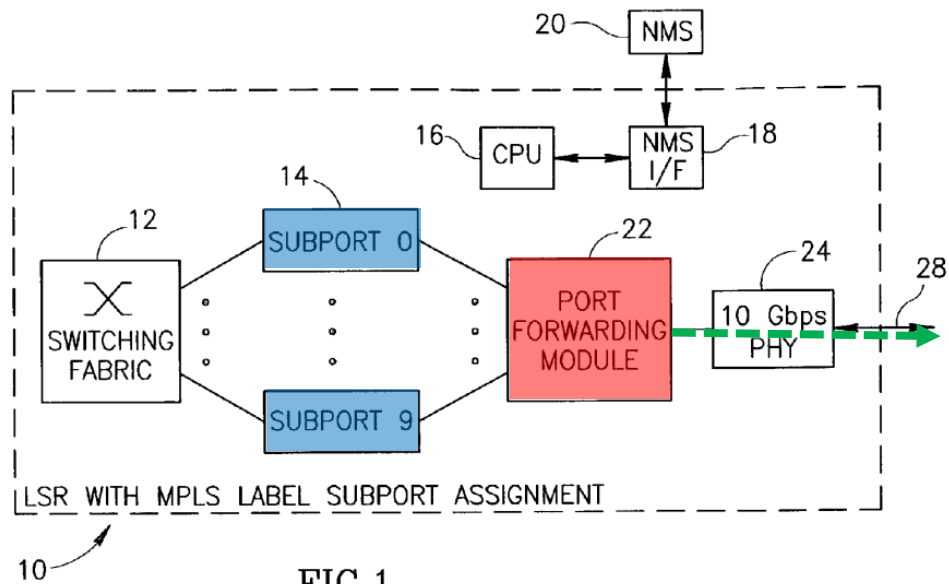
Raz at Fig. 1 (annotated).



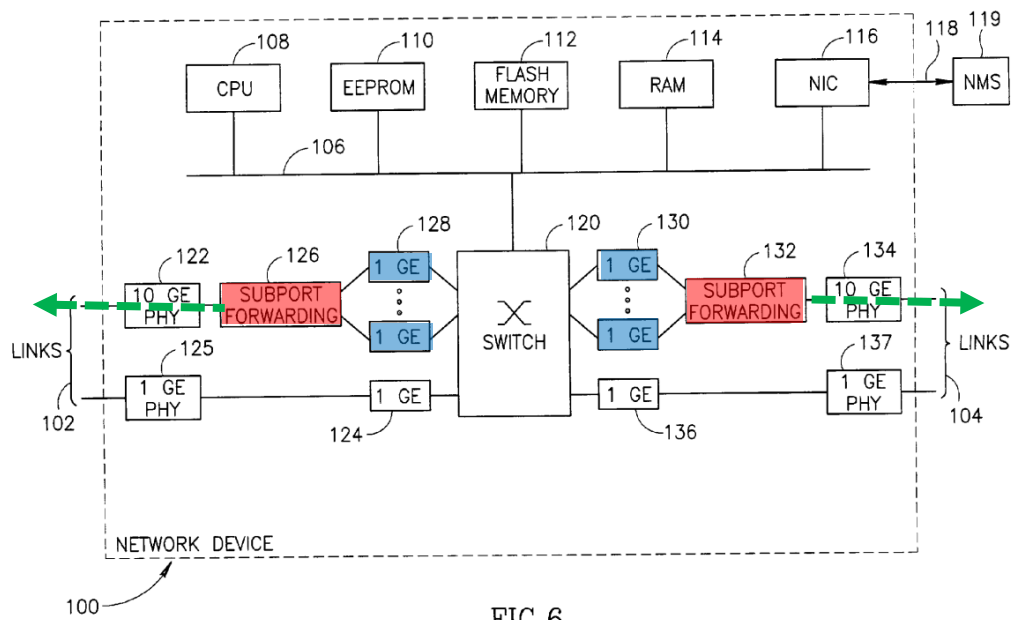
Raz at Fig. 1 (annotated).

128. A POSA would have also understood that, on the other hand, an outbound packet being sent from Raz's subport forwarding module still does not

meet limitation 15.8. That is, Raz teaches that if its subport forwarding module handles an outbound packet being sent to a subsequent different LSR as recited in limitation 15.8, then the subport forwarding module does not send the outbound packet to the subsequent LSR *via a subport* (which Petitioner relies on for the claimed “single physical tunnel port”) as required by limitation 15.8. Pet. 45, 16-20 (relying on Raz’s subport as the claimed “single physical tunnel port” for claim 15); Raz at Fig 1, Fig. 6, 3:28-30, 7:39-42, 16:43-50. This teaching is demonstrated by the following annotated versions of Raz’s Figures 1 and 6 below. These annotated figures both show how an outbound packet (green dashed line) sent from a given LSR to a different LSR by the subport forwarding module (red) is not sent “via” a subport (blue) as required by limitation 15.8 (based on Petitioner’s argument that Raz’s subport constitutes the claimed “single physical tunnel port”).



Raz at Fig. 1 (annotated).



Raz at Fig. 1 (annotated).

129. **Third** — It is my opinion that the deficiency in Raz described above, in that Raz's subport forwarding module fails to meet limitations 15.5–15.8, is not

remedied by Petitioner's obviousness arguments. Based on my review, I understand that the Petitioner's obviousness arguments for claim 15 do not even mention Raz's subport forwarding module, much less explain specifically why or how a POSA would have purportedly modified Raz's subport forwarding module to meet the limitations of claim 15. Pet. 40-48.

130. I understand that for limitation 15.8, Petitioner and Dr. Bhattacharjee merely assert that "a POSA would have been motivated to communicate packets from a first MPLS/LAG switch to a second MPLS/LAG switch in a MPLS network in the same way as packets communicated from one LSR to another in Raz." Pet. 48 (citing Ex.1004 ¶181, which cites no evidence and provides no explanation for this assertion). If anything, this assertion by Petitioner acknowledges that even if a LAG were added between two LSRs in Raz as Petitioner asserts, then Raz's port forwarding module would still just communicate a packet via that LAG in "the same way" as Raz's port forwarding module already communicates a packet between LSRs, which does not meet limitation 15.8, as I explain above.

131. I also understand that for limitation 15.8, Petitioner asserts, with respect to the example in column 7 of Raz, that "[a] POSA would have understood that a data packet in LSR B could be sent to another LSR ... via a physical tunnel subport (subport 3)." Pet. 48 (citing Raz at 7:39-45). But a POSA would have

understood that this assertion does not and cannot overcome the fact that, as explained above, Raz's subport forwarding module (i.e., the alleged "mapper") does not send outbound packets to other LSRs *via Raz's subport* (i.e., the alleged "physical tunnel port") as recited in limitation 15.8. Petitioner's assertion regarding the example in column 7 is thus wrong and insufficient to show that Raz meets limitation 15.8. Moreover, a POSA would have understood that Petitioner's assertion mischaracterizes the cited portion of Raz, which actually refers to an inbound packet received by LSR B, not an outbound packet transmitted from LSR B to some other LSR. Raz at 7:39-45 (discussing the scenario of "[w]hen a packet ... is *received* over a link connected to LSR A" such that the packet "is forwarded ... out over the 10G link *to* LSR B" (emphases added)).

132. **Fourth** — It is my opinion that Petitioner fails to establish that Raz teaches or renders obvious limitation 15.8 for the same reasons as limitation 1.5. I understand that limitations 1.5 and 15.8 are substantially similar, as both recite, for example, that a data packet is sent "to [the] second MPLS/LAG switch via said single physical tunnel port," wherein the "single physical tunnel port of a LAG" is assigned and is indicated in a "data packet label" that is published upstream (or sent to a preceding node) and then included in the data packet that is received from an upstream node (or the preceding node) and sent to the second MPLS/LAG switch. Also, based on my review, I understand that Petitioner's analysis for

limitation 15.8 is substantially similar to its analysis for limitation 1.5, as are the paragraphs of Dr. Bhattacharjee's declaration relied upon for each. *Compare* Pet. 47-48 and Ex.1004 ¶¶107-108 *with* Pet. 24 and Ex.1004 ¶¶180-181. It is thus my opinion that Petitioner's analysis of limitation 15.8 fails for the same reasons discussed in sections VIII.E.1.a–b above regarding limitation 1.5.

G. Independent Claim 26

133. It is my opinion that Raz does not render obvious independent claim 26 of the '602 patent.⁷ As explained in sections VIII.A–C above, Raz fails to render obvious the challenged claims because Raz is fundamentally different from the claimed inventions of the '602 patent, a POSA would not have modified Raz to arrive at the '602 patent's claimed inventions (including claim 26), and Petitioner fails to establish either a motivation to modify or reasonable expectation of success.

134. Also, as explained in section VIII.E above, it is my opinion that Raz does not render obvious claim 1. I understand that claim 26 is substantially similar to claim 1, as limitations 26.2–26.6 are substantially similar to limitations 1.1–1.5, and claim 26 includes an additional limitation not included in claim 1, i.e., limitation 26.1. I further understand that Petitioner expressly relies on its analysis of limitations 1.1–1.5 for purposes of limitations 26.2–26.6. Pet. 49-52. Thus, it is

⁷ The entirety of claim 26 is quoted in section VIII.A above.

my opinion that section VIII.E above is also applicable regarding claim 26, such that Raz does not render obvious claim 26 and Petitioner's obviousness analysis for claim 26 fails for the same reasons explained in section VIII.E.

IX. Ground 2: The Combination of Raz and Ferguson Does Not Render Obvious Claims 1-26

135. I understand that in Ground 2, Petitioner asserts that claims 1-26 are obvious over Raz and Ferguson. But the combination of Raz and Ferguson does not render obvious claims 1-26, including because (i) a POSA would not have modified Raz based on Ferguson to arrive at the claimed inventions of the '602 patent, (ii) Petitioner has failed to establish a motivation to modify Raz with Ferguson to arrive at the claimed inventions of the '602 patent, (iii) Petitioner has failed to establish a reasonable expectation of success for any such modifications, and (iv) even if Raz is modified based on Ferguson as Petitioner asserts, the claims are not rendered obvious.

136. I understand that Petitioner's Ground 2 claims to "incorporate[] by reference" its Ground 1 obviousness analysis. Pet. 52. Thus, I similarly incorporate by reference here into Ground 2 my analysis of Ground 1 in section VIII above.

A. A POSA Would Not Have Modified Raz Based on Ferguson to Arrive at the Claimed Inventions of the '602 Patent

137. It is my opinion that a POSA would not have been motivated to modify Raz based on Ferguson to apply Raz's teachings to communication via a LAG in an MPLS network between two MPLS/LAG switches, as recited in the challenged claims of the '602 patent.

138. First, as I explain in section VIII.B above, it is my opinion that a POSA would not have been motivated to modify Raz to arrive at the claimed inventions of the '602 patent. For example, as explained in that section, it is my opinion that Raz teaches away from applying its subport-related teachings to an external LAG and that applying Raz's subport-related teachings to communications between two MPLS/LAG switches would have rendered Raz inoperable or unsatisfactory for its intended purpose. That same opinions and analysis apply with respect to Ground 2. It is my opinion that despite Ferguson, a POSA still would not have modified Raz to arrive at the claimed inventions of the '602 patent. Also, based on my review, Petitioner does not rely on Ferguson to remedy those issues explained in section VIII.B, as Petitioner does not rely on modifying Raz to incorporate any elements of Ferguson but rather simply modifying Raz in the same manner as for Ground 1, just based on alleged motivations from Ferguson. *See* Pet. 52-59. Indeed, I understand that the Petition

“incorporates by references” its “analysis of ... obviousness ... set forth ... in Ground 1.” Pet. 52.

139. Second, it is my opinion that a POSA would not have been motivated to modify Raz’s teachings regarding subparts *within* an LSR to apply to communications *between* LSRs in view of Ferguson.

140. A POSA would have understood Ferguson to describe techniques for distributing label switched packets of a single LSP across multiple physical interconnects of an aggregated link. Ferguson at Abstract, Figs. 1-2C, 1:57-63, 2:4-6, 2:40-47, 3:36-4:8, 6:15-31, claim 1. A POSA would have also understood that Ferguson teaches that packets may be distributed across multiple interconnects of an aggregated link based on, for example, the type of payloads in the packets. Ferguson at Abstract, 2:35-38, 3:16-18, 4:9-19, 4:45-5:24. A POSA would have also understood that Ferguson states its techniques may be used to “load balance” packets of a single LSP across the multiple physical interconnects of an aggregated link. Ferguson at Abstract, 1:57-63, 2:54-57, 4:45-49. A POSA would have also understood that Ferguson further discloses that its distribution techniques may be applied to distribute packets of a common LSP across multiple paths within a network device, such as a router. Ferguson at 1:63-66, 5:61-6:9 (stating that “[a]though [Ferguson’s] techniques have been described in reference to” an

external aggregated link, “[Ferguson’s] techniques may be readily applied to internal parallel data paths within a device”).

141. As explained in section VIII.B above, however, it is my opinion that a POSA would have understood Raz to be specifically and solely directed to a provisioning mechanism for *inside* a network device such as an LSR and teaches away from applying its subport-related teachings to an external link between two LSRs. Raz at Abstract, 1:40-2:3, 6:24-27, 6:51-54. For example, a POSA would have understood that Raz is premised on solving a problem related to internal processing capacity of a network device, such as an LSR, by specifically and intentionally using its subports *within* the device. 1:40-2:3.

142. Additionally, it is my opinion that while Ferguson teaches that its own techniques for communications between routers may be applied within a router (Ferguson at 5:61-6:9), a POSA would not have understood, based on Ferguson, that the opposite is true for any teachings outside of Ferguson, such as the teachings of Raz. That is, despite Ferguson teaching that Ferguson’s own techniques may apply within a router, a POSA would not have been motivated to take Raz’s provisioning mechanism for within an LSR and attempt to apply it to communications between LSRs. This is because a POSA would have understood that Ferguson’s teaching about applying techniques within a router is limited to Ferguson’s own techniques and does not apply to Raz’s techniques. Ferguson at

5:61-6:9. This is also because Ferguson’s teaching is about taking techniques for communicating between routers and applying them to within a router, not taking techniques for within a router (such as Raz’s mechanism) and applying them to communications between routers. Ferguson at 5:61-6:9

143. Additionally, it is my opinion that a POSA would not have been motivated to modify Raz based on Ferguson because Ferguson and Raz address different problems. As I explain in section VIII.B, a POSA would have understood that Raz is concerned with processing capacity within an LSR and addresses the problem of how an LSR can handle a high-speed link using multiple slow-speed processors. Raz at Abstract, 1:40-2:3, 6:24-27, 14:6-8, 15:14-17, 16:27-29. A POSA would have understood that Ferguson, however, is directed to distributing packets across multiple paths or interconnects, for example, to achieve load balancing and decreased packet latency. Ferguson at Abstract, 1:57-63, 2:54-57, 4:45-60. A POSA would have understood that, unlike Raz, Ferguson assumes the routers have sufficient processing capacity to handle the data communications that Ferguson describes distributing. For example, Ferguson references network devices, such as routers, having “high-speed” components, not low-speed processors like Raz’s subports. *E.g.*, Ferguson at 2:47-53 (“internal high-speed switching components”), 6:2-6 (“internal, high-speed switch fabrics”). Thus, it is

my opinion that a POSA would not have looked to Ferguson when considering Raz.

144. Additionally, it is my opinion that a POSA would have understood that Raz and Ferguson use fundamentally different methods. A POSA would have understood that Ferguson teaches that packets of a single common LSP are distributed across multiple paths or interconnects of an aggregated link. Ferguson at Abstract, Figs. 2A-2C, 1:57-66, 2:4-6, 2:27-34, 2:40-43, claim 1. But a POSA would have understood that Raz's provisioning mechanism, in contrast, teaches that all packets of a given LSP are assigned to the same particular subport in a group of subports, and that different LSPs can be provisioned for different subports in the group. Raz at 7:17-19, 7:26-45, 8:56-58, 9:41-10:4, 11:36-38. This distinction between the teachings of Ferguson and Raz is shown by the annotated versions of Ferguson's Figure 2A and Raz's Figure 1 below. These annotated figures demonstrate how Ferguson distributes packets of a common LSP (dashed green lines) among multiple paths of an aggregate interface, whereas Raz sends all packets of a given LSP (dashed green line) to a single subport (subport 0) of a group of subports and sends all packets of a different LSP (dashed red line) to another single subport (subport 9). Based on my review, Petitioner fails to address this fundamental difference between Ferguson and Raz. *See* Pet. 52-59. It is my opinion that, based on this difference between Ferguson and Raz, and others, a

POSA would not have modified Raz's provisioning mechanism based on Ferguson.

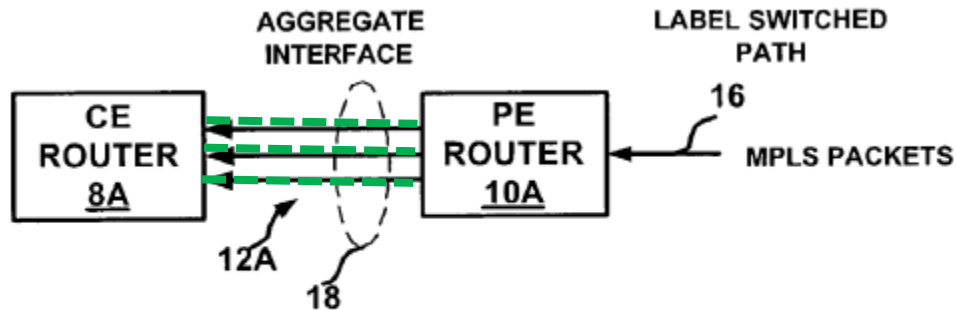


FIG. 2A

Ferguson at Fig. 2A (annotated).

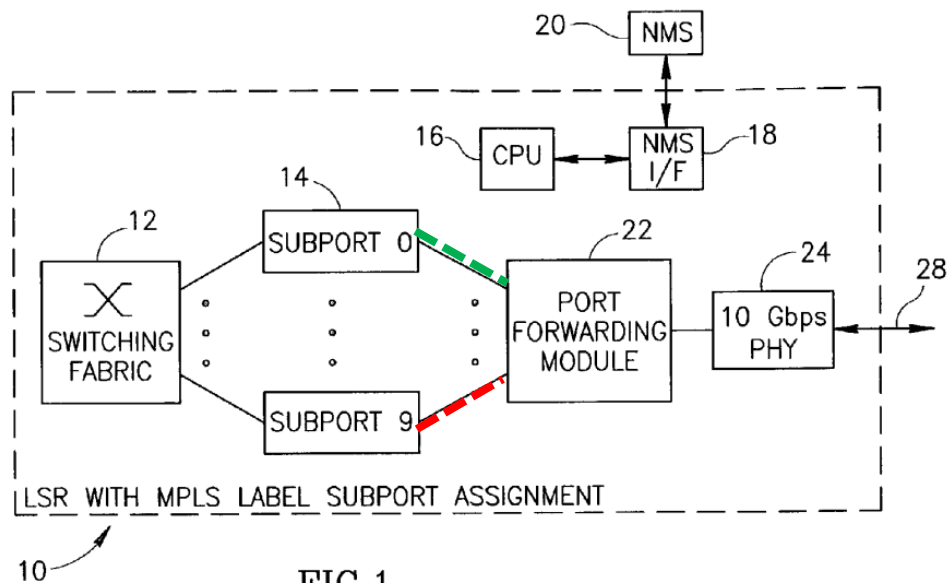


FIG.1

Raz at Fig. 1 (annotated).

145. Additionally, it is my opinion that a POSA would have understood that Ferguson and Raz teach different methods regarding provisioning packet labels and paths. Based on my review, Petitioner does not address the different

methods of Ferguson and Raz regarding packet labels and paths. Pet. 52-59. A POSA would have understood that Raz emphasizes that its subport assignment and label generation comes from downstream, as Raz teaches that a receiving LSR selects a subport, generates a label indicating that subport, and sends that label to an upstream device. Raz at 7:26-38, 8:52-55, 9:41-58. For example, for Raz's embodiment depicted in Figure 3, Raz teaches that LSR C selects subport 1 and sends upstream to LSR B a label indicating subport 1 for LSR B to use in transmitting a data packet to LSR C, and similarly, LSR B selects subport 0 and sends upstream to LSR A a label indicating subport 0 for LSR A to use in transmitting a data packet to LSR C. Raz at Fig. 3, 9:41-10:4. A POSA would have understood that Ferguson, however, does not include any such teachings regarding a packet's label and path being chosen by a downstream router. A POSA would have understood that Ferguson instead teaches that a given router transmits a packet based on the existing label(s) of that packet or selects and prepends its own label to the packet. See Ferguson at 2:4-26, 3:53-4:8, 8:29-57 (describing how CE router 8A of Fig. 1 "selects an appropriate MPLS label ... and pre-pends the label to the packet to form an MPLS packet," and "[o]ther [downstream] devices, such as PE routers 10, may make use of the labels to distribute the MPLS packets"). It is my opinion that this demonstrates a fundamental difference between Raz and Ferguson and that, based on this

difference, a POSA would not have modified Raz's provisioning mechanism based on Ferguson.

146. Additionally, as explained in section VIII.B above, it is my opinion that a POSA would not have applied Raz's subport-related teachings to communications between two MPLS/LAG switches because a POSA would have understood that such modification would have rendered Raz inoperable or unsatisfactory for its intended purpose, regardless of whether such modification was based on Ferguson.

B. Petitioner Fails to Establish a Motivation to Modify Raz with Ferguson to Arrive at the Claimed Inventions of the '602 Patent

147. Based on my review of the Petition and evidence cited therein, the Petition fails to establish that a POSA would have modified Raz at all based on Ferguson, let alone to arrive at the claimed inventions of the '602 patent. It is my opinion that the section of the Petition for Ground 2, and evidence cited therein, fails to establish that a POSA would have modified Raz with Ferguson to meet independent claims 1, 15, or 26, including because petitioner fails to explain specifically *why* or *how* Raz would purportedly be modified based on Ferguson to meet the claim limitations. Pet. 52-60.

148. Based on my review, Petitioner's analysis for Ground 2 is not tied to the claim limitations because it does not perform a limitation-by-limitation analysis of the alleged combination of Raz and Ferguson. Pet. 52-60. I understand that

Petitioner's analysis for Ground 2 states that it "incorporates by reference the analysis of the obviousness ... set forth ... in Ground 1," but Ground 1 does not include Ferguson. Pet. 52.

149. Also, it is my opinion that Petitioner's analysis for Ground 2 fails to explain specifically why or how a POSA would have purportedly modified Raz based on Ferguson. Based on my review, I understand that the Petition does not mention "modify" at all and does not explain, with either words or Raz's figures, precisely *how* a POSA would have modified Raz's forwarding and provisioning mechanism for subports *within* an LSR to apply to communications *between* two MPLS/LAG switches based on Ferguson. Pet. 52-60. Instead, based on my review, I understand that Petitioner's analysis for Ground 2 merely argues that a POSA would have taken Raz's subport-related techniques for within a router and simply applied those techniques to communications between routers, with no discussion regarding how to do this. Pet. 52-59. It is my opinion that Petitioner's analysis for Ground 2 thereby relies on an oversimplification of both Raz and the claim limitations, and this oversimplification highlights the deficiency in Petitioner's analysis for Ground 2.

150. Below are my opinions regarding the various obviousness assertions in the Petition for the independent claims under Ground 2. *See* Pet. 52-59. These opinions are relevant and applicable regarding each of independent claims 1, 15,

and 26 because I understand that Petitioner relies on the same obviousness analysis for all three of these independent claims under Ground 2. *Id.*

151. I understand that Petitioner asserts that Ferguson “addresses the same concerns” as Raz. Pet. 52. But as explained in section IX.A above, a POSA would have understood that Raz and Ferguson address different problems and use different contrasting solutions, including different methods regarding how to handle packets of a given LSP and provision labels/paths.

152. I understand that Petitioner also asserts that “Ferguson teaches a POSA that the method of assigning a subport ... *within* the LSR that is disclosed in Raz could also be implemented *between* MPLS/LAG switches” Pet. 53 (citing Ex.1004 ¶245). But this assertion merely asserts a possibility of how Raz “could” be implemented. I have been informed that such a mere possibility is insufficient to establish a motivation to modify Raz. Regardless, based on my review, I understand that this assertion and the alleged teachings of Ferguson referenced by this assertion do not address the specific teachings of Raz, much less explain how a POSA would have purportedly applied Raz’s subport-related teachings to communications between switches. For example, based on my review, I understand that the cited paragraph of Dr. Bhattacharjee’s declaration (Ex.1004 ¶245) does not contain any citations or discussion regarding the specific teachings of Raz.

153. I understand that Petitioner also asserts that “a POSA reviewing Ferguson would have understood that it would be desirable to implement the techniques in Raz for assigning a ... subport within an LSR to assign a ... port to communicate packets along ‘physical interconnects’ between ‘two switches’” Pet. 53 (citing Ferguson and Ex.1004 ¶245). Based on my review, however, this assertion fails to address the specific teachings of Raz and again relies on the same deficient paragraph of Petitioner’s expert report (Ex.1004 ¶245), which, as noted above, fails to address the specific teachings of Raz. Indeed, based on my review, I understand that Petitioner fails to explain why the generic alleged modification “would be desirable” with respect to Raz. It is my opinion that a POSA would have understood Raz to teach away from the modification because Raz is directed to a provisioning mechanism specifically for *inside* a network device. Raz at Abstract, 1:40-62, 6:24-27, 6:51-54.

154. I understand that Petitioner also asserts that “[t]he teachings of Ferguson are compatible with and readily implementable in the Raz system.” Pet. 53. But it is my opinion that this assertion is conclusory and incorrect. Based on my review, I understand that this assertion is unsupported, as this assertion is followed by the word “CITE” but without any actual citation. Pet. 53. Also, based on my review, I understand that this assertion is conclusory because it fails to identify or discuss in detail the referenced “teachings of Ferguson” or “Raz

system,” much less specifically how the referenced “teachings of Ferguson” are purportedly “compatible with” the “Raz system” as Petitioner asserts. Pet. 53. Also, it is my opinion that this assertion is false because, as explained in section IX.A above, there are fundamental differences between the methods of Ferguson and Raz, including regarding how the two references handle packets of a given LSP and provision labels/paths.

155. I understand that pages 53-54 of the Petition briefly discuss Ferguson’s “aggregate interface” of physical interconnects. Pet. 53-54. Based on my review, however, I understand that this discussion of Ferguson’s “aggregate interface” does not mention or address Raz, much less explain why or how a POSA would have purportedly modified or combined Raz with Ferguson. Pet. 53-54.

156. I understand that Petitioner also asserts that “Ferguson would have taught a POSA that the method of assigning a subport ... within the LSR of Raz could also be implemented between network devices” Pet. 55 (Ex.1004 ¶245).⁸ But this assertion merely asserts a possibility of how Raz “could” be implemented. I have been informed that such a mere possibility is insufficient to

⁸ I note that this assertion is essentially the same as, relies on the same evidence as, and is deficient for the same reasons as Petitioner’s assertion from page 53 of the Petition, which I discuss above, that alleges: “Ferguson teaches a POSA that the method of assigning a subport ... *within* the LSR that is disclosed in Raz could also be implemented *between* MPLS/LAG switches” Pet. 53 (citing Ex.1004 ¶245).

establish a motivation to modify Raz. Regardless, based on my review, I understand that neither this assertion nor the cited paragraph of Dr. Bhattacharjee's declaration (Ex.1004 ¶245) cites or address the specific teachings of Raz, much less explains how a POSA would have purportedly applied Raz's support-related teachings to communications between network devices as Petitioner asserts.

157. I understand that the paragraph spanning pages 55-56 of the Petition asserts that "Ferguson states that the techniques used to communicate ... *within* a router ... can also be applied to communicating ... *between* two routers" Pet. 55-56. **First**, however, it is my opinion that a POSA would have understood that Ferguson actually teaches the opposite, as Ferguson describes techniques in reference to communication *between* routers and then says that those inter-router techniques also "may be ... applied" to within a router. Ferguson at 5:61-6:6. Based on my review, I understand that the remainder of Petitioner's paragraph actually acknowledges this when it quotes the language from Ferguson. Pet. 55 (quoting Ferguson at 5:61-6:6). **Second**, it is my opinion that a POSA would have understood that Ferguson teaches this about "its" techniques but not Raz's techniques. Pet. 55; 5:61-6:6. A POSA would have understood that Ferguson does not cite, discuss, or relate to Raz's techniques. Also, as explained in section IX.A above, a POSA would have understood that there are fundamental differences between the techniques of Ferguson and Raz. **Third**, based on my review, I

understand that neither this paragraph of the Petition nor the paragraph of Dr. Bhattacharjee's declaration cited therein (Ex.1004 ¶245) contains any citation or discussion of Raz's specific teachings. *See* Pet. 55-56. Ultimately, it is my opinion that although Ferguson teaches that its communications between routers can also apply within a single router, a POSA would have understood that this does not mean the opposite is true for Raz—i.e., Ferguson's teaching does not mean that Raz's teachings about communications within a single router can apply to communications between routers.

158. I understand that the first full paragraph on page 56 of the Petition asserts that based on the "disclosures of Ferguson," "a POSA would have understood that the techniques disclosed in Raz for ... within a LSR ... could also be applied" between LSRs. Pet. 56 (citing Ex.1004 ¶245). But based on my review, I understand that neither this paragraph of the Petition nor the paragraph of Dr. Bhattacharjee's declaration cited therein (Ex.1004 ¶245) contains any citation or discussion of Raz's actual specific teachings, much less explains specifically how a POSA would have purportedly modified Raz to apply to communications between LSRs. *See* Pet. 56. Moreover, it is my opinion that a POSA would not have understood Raz's techniques to be applicable between LSRs based on Ferguson because, as explained in section IX.A above, a POSA would have

understood that there are fundamental differences between the methods of Ferguson and Raz.

159. I understand in that same paragraph (i.e., the first full paragraph on page 56 of the Petition), Petitioner also asserts that “packets are communicated the same way within a device as between devices” (Pet. 56) and later that the “same techniques” could be used for both inside and between LSRs (Pet. 59). But it is my opinion that these assertions are conclusory and incorrect. Based on my review, I understand that neither of these assertions includes an explanation as to *how* Raz’s techniques would allegedly be applied the “same” for both within and between LSRs. Pet. 56, 59. Also, as explained for Ground 1, including in at least sections VIII.B–C above, it is my opinion that Raz could not be applied the “same way” for both within and between LSRs.

160. I understand that Petitioner also asserts that “both Raz and Ferguson are directed to solving the problem of ensuring enough bandwidth is available to communicate high-speed packet streams through an MPLS network.” Pet. 57-59. It is my opinion, however, that this assertion mischaracterizes Raz, as a POSA would have understood that Raz is not concerned with “bandwidth ... to communicate high-speed packet streams through an MPLS network” as Petitioner asserts. A POSA would have understood that Raz is instead concerned with the problem of processing capacity/bandwidth *within* a network device for handling a

high-speed packet stream communicated through the network. Raz at Abstract, 1:40-2:3, 6:24-27, 14:6-8, 15:14-17, 16:27-29; section VIII.B *supra*. To the extent Raz discloses bandwidth allocation, in my opinion, it is with respect to allocating bandwidth of subports, which are *within* an LSR. Abstract (“allocating subport bandwidth”), Fig. 5 (“subport bandwidth allocation method”), 2:23-25, 8:1-4, 11:60-12:9. I understand that Petitioner admits that “Raz discusses allocating the bandwidth of subports *within an LSR*.” Pet. 57 (emphasis added).

161. I understand that Petitioner also asserts that “[a] POSA would have understood from ... Ferguson that techniques ... to communicate data packets between routers ... are also applicable to the use of subports ... within the routers ..., and vice versa,” such that “a POSA would have known that the techniques disclosed in Raz ... would also have been applicable to ... between routers” Pet. 59. **First**, however, in my opinion, a POSA would have understood that Ferguson does not teach the alleged “vice versa”—i.e., that a technique described for within a router is also applicable between routers. Based on my review, Petitioner cites no support for this “vice versa.” I understand that Petitioner cites Ferguson at 5:61-6:6 and Ex.1004 ¶250, which also cites Ferguson at 5:61-6:6. Pet. 59. But a POSA would have understood that cited portion of Ferguson to show that Ferguson actually teaches the opposite of the alleged “vice versa,” as that cited portion says that Ferguson’s techniques are “described in reference to”

an external link between routers and “may be ... applied” to within a router.

Ferguson at 5:61-6:6. At most, a POSA would have understood that this disclosure in Ferguson teaches that Ferguson’s techniques can apply to both between and within routers. *Id.* But in my opinion, a POSA would have understood that Ferguson does not describe techniques for within a router and then state that those methods can be extended to apply between routers.

162. **Second**, regardless of whether Ferguson teaches the alleged “vice versa,” it is my opinion that a POSA would have understood that the relied-upon teaching in Ferguson (5:61-6:6) is about only Ferguson’s own techniques, not Raz or its subports and subport-related mechanism. *See* Ferguson at 5:61-6:6 (discussing “the techniques [that] have been described,” i.e., Ferguson’s techniques); Pet. 55 (acknowledging that this portion of Ferguson is about “[its] techniques,” i.e., Ferguson’s techniques). In my opinion, a POSA would not have understood this teaching in Ferguson to apply to Raz and would not have been motivated by this teaching in Ferguson to extend Raz’s mechanism for within a router to apply to between routers. Indeed, based on my review, I understand that in the paragraph on page 59 of the Petition that contains the above-noted assertion, Petitioner does not discuss any particulars of either Ferguson or Raz’s techniques, much less compare their particular techniques to explain why or how the disclosures regarding Ferguson’s techniques would also apply to Raz’s techniques.

Pet. 59. For example, I understand that this paragraph of the Petition refers generically to “the techniques disclosed in Raz for using subports to transmit data packets within a router or switch,” with no analysis of the particulars of those techniques in Raz. Pet. 59. Further, based on my review, I understand that neither this paragraph of the Petition nor the paragraph of Dr. Bhattacharjee’s declaration cited therein (Ex.1004 ¶250) contains a single cite to Raz. Pet. 59.

163. In sum, it is my opinion that the Petition fails to establish a motivation to modify Raz with Ferguson. Based on my review, the Petition does not explain specifically why or how a POSA would have modified or combined the particular teachings of Raz and Ferguson to meet all of the claim limitations of independent claims 1, 15, and 26.

C. Petitioner Fails to Establish a Reasonable Expectation of Success

164. Based on my review of the Petition and evidence cited therein, the Petition does not contain persuasive argument or evidence that a POSA would have had a reasonable expectation of success for modifying Raz based on Ferguson to meet the challenged claims.

165. I have been informed that obviousness requires that a POSA would have had a reasonable expectation of success in modifying the prior art to meet the claims and that this reasonable expectation of success is separate from the requisite motivation to modify the prior art.

166. Based on my review, it is my opinion that Petitioner does not present any argument, much less a persuasive argument, regarding whether a POSA would have had a reasonable expectation of success in modifying Raz to meet the claims. There is no mention of any “reasonable expectation of success” in either the Petition or Dr. Bhattacharjee’s declaration, except for the Dr. Bhattacharjee’s discussion of the applicable law. Ex.1004 ¶14.

167. Indeed, in my opinion, a POSA would not have had a reasonable expectation of success of modifying Raz’s mechanism based on Ferguson to meet the claims, as a POSA would not have even had a reasonable expectation of success of somehow applying Raz’s mechanism to communications between two network devices (such as the claimed MPLS/LAG switches) to begin with, even in view of Ferguson. As explained in sections VIII.B–C above, Raz’s mechanism involves several teachings that are incompatible with communications between network devices, and modifying of Raz to apply to such communications between network devices would render Raz inoperable or unsatisfactory for its intended purpose (i.e., its purpose of provisioning data across subports *within* a single network device). A POSA would have understood that combining Raz with Ferguson as Petitioner asserts would not have cured these issues.

D. Even if Raz is Modified Based on Ferguson as Petitioner Asserts, the Claims Are Not Rendered Obvious

168. It is my opinion that even if a POSA would have modified Raz based on Ferguson as Petitioner asserts, this would nonetheless fail to render obvious independent claims 1, 15, and 26.

169. I understand that Petitioner asserts for Ground 2 that Raz would have been modified in view of Ferguson to apply to communications between two MPLS/LAG switches via a LAG. Pet. 52-59.

170. As I explain in section VIII.E.2.c above, however, it is my opinion that even if a POSA had been motivated to, and had the capability to, somehow modify Raz to apply to communications between two MPLS/LAG switches via a LAG, as Petitioner asserts for Ground 2, such modification would still not meet claim 1, including limitation 1.5 in particular. Also, as explained in at least section VIII.G above, claim 26 includes substantially similar limitations as claim 1 and is thus non-obvious for the same reasons as claim 1. Thus, it is my opinion that the arguments in section VIII.E.2.c above are also applicable for claims 1 and 26 under Ground 2, such that the combination of Raz and Ferguson does not render obvious claims 1 and 26.

171. Additionally, as explained in section VIII.F.2 above, it is my opinion that Raz's subport forwarding module fails to meet limitations 15.5–15.8 and that Petitioner's obviousness analysis of claim 15 for Ground 1 does not remedy Raz's

deficiency. Based on my review, I understand that Petitioner's obviousness analysis for Ground 2 does not specifically address Raz's subport forwarding module or limitations 15.5–15.8 (*see* Pet. 52-59), and therefore, Petitioner's obviousness analysis of claim 15 for Ground 2 likewise does not remedy this deficiency for purposes of Ground 2. Thus, it is my opinion that Petitioner's obviousness analysis of claim 15 for Ground 2 fails, such that the combination of Raz and Ferguson does not render obvious claim 15.

X. Conclusion

172. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: November 19, 2023



George N. Rouskas, Ph.D.

Appendix A

VITA

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November 2023

Education

Ph.D.	1994	Georgia Institute of Technology	Computer Science
M.S.	1991	Georgia Institute of Technology	Computer Science
B.S.	1989	National Technical University of Athens	Computer Engineering

Employment History

Alumni Distinguished Graduate Professor (Professor 2002-2018 Associate Professor 1999-2002 Assistant Professor 1994-1999)	Department of Computer Science North Carolina State University Raleigh, NC	1994-present
Director of Graduate Programs	Department of Computer Science	January 2014-present

Visiting Positions

Distinguished Scientist	King Abdulaziz University, Saudi Arabia	2013-2021
Visiting Professor	Laboratoire d'Informatique University of Paris 6, France	October 2012
Visiting Professor	Universidad Tecnica Federico Santa Maria, Chile	December 2008
Visiting Professor	Laboratoire de Méthodes Informatiques University of Evry, France	July 2006 December 2002 June 2000
Network Architect (Sabbatical)	Vitesse Semiconductor	August 2000-May 2001

Honors and Awards

OUTSTANDING SERVICE AWARD, Optical Networking Tech. Cmte (ONTC), IEEE Commun. Society, 2019

ALUMNI DISTINGUISHED GRADUATE PROFESSOR, NC State, 2018

JOYCE HATCH SERVICE AWARD, NC State Chapter of ACM/AITP, 2015

MOST RECEPTIVE GRADUATE PROFESSOR AWARD, NC State Chapter of ACM/AITP, 2014

FELLOW, INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE), 2012

CAROL MILLER GRADUATE LECTURER AWARD, NC State Chapter of ACM/AITP, 2012

IEEE DISTINGUISHED LECTURER, 2010-2011

OUTSTANDING SERVICE AWARD, IEEE GLOBECOM, 2010

IBM FACULTY AWARD, 2007

BEST PAPER AWARD, *EVGM Workshop*, 2007 (with C. Castillo and K. Harfoush)

BEST PAPER AWARD, *CSNDSP Symposium*, 2006 (with B. Chen and R. Dutta)

ALCOA FOUNDATION ENGINEERING RESEARCH ACHIEVEMENT AWARD, CoE, NC State, 2004

ACADEMY OF OUTSTANDING TEACHERS, NC State, 2004

ALUMNI OUTSTANDING RESEARCH AWARD, NC State, 2003

BEST PAPER AWARD, *SPIE Conference on All-Optical Networking*, 1998 (with I. Baldine)

CAREER AWARD, NATIONAL SCIENCE FOUNDATION (NSF), 1997

OUTSTANDING NEW TEACHER AWARD, Department of Computer Science, NC State, 1995

GRADUATE RESEARCH AWARD, College of Computing, Georgia Institute of Technology, 1994

I. Teaching and Mentoring

Courses Taught

- CSC 316 – DATA STRUCTURES (undergraduate)
- CSC 401 – COMPUTER NETWORKS (undergraduate)
- CSC/ECE 573 – INTERNET PROTOCOLS (graduate)
- CSC/ECE 579 – INTRODUCTION TO COMPUTER PERFORMANCE EVALUATION (graduate)
- CSC/ECE 772 – SURVIVABLE NETWORKS (graduate)
- CSC/ECE 778 – OPTICAL NETWORKS (graduate)

Visiting Scholars

4. DR. KAMAL JAMBI, 2018-19 (King Abdulaziz University, Jeddah, Saudi Arabia)
Research: *Machine Learning Applications to Network Control Plane*
3. DR. YU XIONG, 2016-2017 (Chongqing University of Posts and Telecommunications (CUPT), China)
Research: *Optical and Datacenter Networks*
2. DR. OMAR BATARFI, 2014-2015 (King Abdulaziz University, Jeddah, Saudi Arabia)
Research: *Visible Light Communications*
1. DR. EVRIPIDIS BAMPIS, 2005-2006 (Paris VI University, France)
Research: *Packet Scheduling*

Post Doctoral Fellows

3. DR. EMRE YETGINER, 2008-2009
Research: *Traffic Grooming for Green Optical Networking*
2. DR. A. HALIM ZAIM, 2001-2002
Research: *Implementation of Signaling Protocols for Optical Burst-Switched Networks*
1. DR. SRIDHAR RAMESH, 1999-2000
Research: *Performance Analysis of Wavelength Routed Networks*

Ph.D. Students Supervised – Graduated

25. LINGNAN GAO, 2019
Dissertation: *Resource Allocation in Virtual Network Environments*
Outstanding Research Award, 2019
Outstanding Teaching Assistant Award, 2016
24. SHIREESH BHAT, 2017
Dissertation: *Network Service Orchestration within the ChoiceNet Architecture*
23. RAMESH KRISHNAMURTHY, 2016
Dissertation: *A Framework for Evaluating Server Performance: Application to SIP Proxy Servers*

22. SAHAR TALEBI, 2015
Dissertation: *On Routing and Spectrum Assignment in Elastic Optical Networks*
21. AHMET CAN BABAOGLU, 2014
Dissertation: *Verification Services for the Choice-Based Internet of the Future*
20. HUI WANG, 2013
Dissertation: *Efficient Decomposition Techniques for Traffic Grooming Problems in Optical Networks*
19. ZEYU LIU, 2012
Dissertation: *On Routing and Wavelength Assignment in WDM Networks*
18. MOHAN IYER, 2010
Dissertation: *Providing Bandwidth on Demand Services Using Optical Network Design and the SILO Network Architecture*
Outstanding Teaching Assistant Award, 2009
17. QIAN LV (2010)
Dissertation: *Economic Models for Internet Tiered Services*
16. ANJING WANG, 2010
Dissertation: *Optimization of Silo Services for the Future Internet*
Outstanding Teaching Assistant Award, 2009
15. ZYAD DWEKAT 2009
Dissertation: *Practical Fair Queueing Schedulers: Simplification Through Quantization*
14. CLARIS CASTILLO, 2008
Dissertation: *Scheduling and Resource Management in Grids*
College of Engineering Nancy G. Pollock PhD Dissertation Award, 2008
Google Anita Borg Scholarship, 2007
Outstanding Teaching Assistant Award, 2006
13. LI YANG, 2006
Dissertation: *Congestion Control and Quality of Service (QoS) Provisions for Optical Burst Switched Networks*
12. BENSONG CHEN, 2005
Dissertation: *Hierarchical Traffic Grooming in Large-Scale WDM Networks*
Outstanding Teaching Assistant Award, 2004
11. JING TENG, 2004
Dissertation: *A Study of Optical Burst Switched Networks with the Jumpstart Just-In-Time Signaling Protocol*
10. LAURA E. JACKSON, 2003
Dissertation: *The Directional p-Median Problem with Applications to Traffic Quantization and Multi-processor Scheduling*
GAANN Fellow, 2000-2003
College of Engineering Nancy G. Pollock PhD Dissertation Award, 2004
9. YUFENG XIN, 2002
Dissertation: *Topology Design of Large-Scale Optical Networks*
8. LISONG XU, 2002
Dissertation: *Performance Analysis of Optical Burst Switched Networks*
NSF CAREER Award, 2007

7. RUDRA DUTTA, 2001
Dissertation: *Virtual Topology Design for Traffic Grooming in Optical WDM Networks*
6. A. HALIM ZAIM, 2001
Dissertation: *Computing Call Blocking Probabilities in LEO Satellite Networks*
5. YUHONG ZHU, 1999
Dissertation: *Computation of Blocking Probabilities in Wavelength Routing Networks*
4. ILYA BALDIN, 1998
Dissertation: *Dynamic Reconfiguration in Broadcast WDM Networks*
3. ZEYDY ORTIZ-LAUREANO, 1998
Dissertation: *Techniques to Support Multicast Traffic in Single-Hop WDM Optical Networks*
NSA Fellow, 1994-1998
2. M. WILLIAM (BILL) MCKINNON, 1997
Dissertation: *Performance Analysis of a Class of Photonic Interconnection Architectures*
1. SUPRIYA S. SHARMA, 1997
Dissertation: *Optimal Buffer Management for Shared Buffer ATM Switches*

Visiting Ph.D. Students

5. FENGXIAN TANG, 2019-2020 (Soochow University, China)
Research: *Optical Network Optimization*
4. WENZHE LI, 2017-2018 (Beijing University of Posts and Telecommunications, China)
Research: *Optical Networks on a Chip (ONoC)*
3. XIAOMIN LIU, 2011-2012 (Beihang University, China)
Research: *Ethernet Passive Optical Networks*
2. CHANG CAO, 2010-2011 (Beijing University of Posts and Telecommunications, China)
Research: *p-Cycle Protection in MPLS Networks*
1. ARUN VISWANATH, 2007-2008 (University of New South Wales, Australia)
Research: *Buffer Sizing in High-Speed Routers*

M.S. Students Supervised – Graduated

12. MANOJ VELLALA, 2008
Thesis: *Stack Composition for SILO Architecture*
11. SRIKRISHNA GIRISH KHARE, 2008
Thesis: *Linux Implementation of Tiered Service Fair Queueing (TSFQ) Scheduling Disciplines*
10. AJAY BABU AMUDALA BHASKER, 2006
Thesis: *Tiered-Service Fair Queueing (TSFQ): A Practical and Efficient Fair Queueing Algorithm*
9. NIKHIL BARADWAJ, 2005
Thesis: *Traffic Quantization and its Application to QoS Routing*
Graduate School Nancy G. Pollock MS Thesis Award, 2006

8. VIJAY IYER, 2002
Thesis: *A Simulation Study of Wavelength Assignment and Reservation Policies with Signaling Delays*
7. MRUGENDRA SINGHAI, 2002
Thesis: *Helios 2: An All-Optical Broadcast Local Area Network*
6. SUDHIN BENGARI, 2001
Thesis: *Differentiated Services Support for the Helios Optical WDM Testbed*
5. DHAVAL THAKER, 2001
Thesis: *Multicasting in a Partially Tunable Broadcast WDM Network*
4. JEFFREY J. STUCKEY, 1998
Thesis: *Worst-Case Cell Delay in an ATM Switch Using EDF Scheduling*
3. BRIAN K. HABERMAN, 1997
Thesis: *Cost, Delay, and Delay Variation Conscious Multicast Routing*
2. ILYA BALDIN, 1995
Thesis: *Multicast Routing With End-to-End Delay and Delay Variation Constraints*
1. VIJAY SIVARAMAN, 1995
Thesis: *TDM Schedules For Broadcast WDM Networks With Arbitrary Tuning Latencies*

II. Research and Scholarship

Books

3. ROUSKAS, G.N., RAMAMURTHY, B., SIVALINGAM, K.M. (editors). Next-Generation Internet Architectures and Protocols. Cambridge University Press, 2011.
2. ROUSKAS, G.N. Internet Tiered Services: Theory, Economics, and Quality of Service. Springer, 2009.
1. DUTTA, R., KAMAL, A., ROUSKAS, G.N. (editors). Traffic Grooming for Optical Networks: Foundations, Techniques, and Frontiers. Springer, 2008.

Book Chapters

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4. XU, L., PERROS, H.G., ROUSKAS, G.N., "Access Protocols for Optical Burst-Switched Ring Networks." In *Proceedings of the 6th Joint Conference on Information Sciences (JCIS 2002)*, pp. 1287-1290, March 8-13, 2002, RTP, North Carolina.

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2. DUTTA, R., ROUSKAS, G.N., "Topology Design in WDM Rings to Minimize Electronic Routing: Efficient Computation of Tight Bounds." In *Proceedings of the 38th Allerton Conference on Communication, Control, and Computing*, pp. 1284-1293, October 4-6, Monticello, Illinois, 2000.
1. ROUSKAS, G.N., "A Comparison of Allocation Policies in Wavelength Routing Networks." In *Proceedings of the 37th Allerton Conference on Communication, Control, and Computing*, pp. 669-678, September 22-24, Monticello, Illinois, 1999.

Tutorials

4. ROUSKAS, G.N., "Tutorial on Network Virtualization." Presented at the *OFC 2012* Conference, March 2012, Los Angeles, California.
3. ROUSKAS, G.N., "Tutorial on Traffic Grooming and Multigranular Switching in Optical WDM Networks." Presented at the *NETWORKING 2004* Conference, May 9, 2004, Athens, Greece.
2. ROUSKAS, G.N., "Tutorial on Traffic Grooming and Multigranular Switching in Optical WDM Networks." Presented at the *IEEE INFOCOM 2004* Conference, March 7, 2004, Hong Kong.
1. ROUSKAS, G.N., PERROS, H.G., "Tutorial on Optical Networks." In E. Gregori *et al.*, (editors), *Advanced Lectures on Networking: Networking 2002 Tutorials*, Springer-Verlag LNCS 2497, pp. 155-193, 2002. Presented at the *NETWORKING 2002* Conference, May 19, 2002, Pisa, Italy.

Keynotes, Distinguished Lectures, and Panels

- Distinguished Lecture (virtual), Institute of Broadband Research and Innovation, Soochow University, China, October 2021.
- Distinguished Lecture (virtual), Istanbul Commerce University, Turkey, May 2021.
- Distinguished Lecture (virtual), Department of Computer and Information Sciences, Temple University, February 2021.
- Distinguished Lecture (virtual), School of Science, Beijing University of Posts and Telecommunications, Beijing, China, September 2020.
- Distinguished Lecture, CE Department, National Technical University of Athens, June 2019
- Distinguished Lecture, CSE Department, University at Buffalo, April 2019
- Panel on "Innovation Opportunities in Transport Networks from Network Analytics and Machine Learning." OFC 2019, March 2019.
- Panel on "Future Directions for IoT." IEEE MASS 2018, October 2018.
- Distinguished Lecture, East Carolina University, April 2017
- Distinguished Lecture, National Conference for Colleges of Computing (NC3), Jeddah, Saudi Arabia, February 2016
- Distinguished Lecture, King Abdulaziz University, Saudi Arabia, April 2015

- Distinguished Lecture, King Abdulaziz University, Saudi Arabia, February 2014
- Distinguished Lecture, King Abdulaziz University, Saudi Arabia, May 2013
- CS Distinguished Lecture, Iowa State University, April 2012
- Panel on “Future Internet: Do We Need Fundamentally New Designs?.” IEEE LANMAN workshop, Chapel Hill, NC, October 2011
- Keynote, ICIIS Conference, Kandy, Sri Lanka, August 2011
- IEEE Distinguished Lecture, University of Colombo, Sri Lanka, August 2011
- IEEE Distinguished Lecture, University of Moratuwa, Sri Lanka, August 2011
- IEEE Distinguished Lecture, The University of West Indies, Kingston, Jamaica, May 2011
- IEEE Distinguished Lecture, IEEE Communications Society Chapter, Orlando, FL, May 2011
- IEEE Distinguished Lecture, University of Alabama at Huntsville, Huntsville, AL, May 2011
- IEEE Distinguished Lecture, University of Alabama at Birmingham, Birmingham, AL, October 2010
- IEEE Distinguished Lecture, Verizon, Temple Terrace, FL, October 2010
- IEEE Distinguished Lecture, IEEE Communications Society Chapter, Orlando, FL, October 2010
- IEEE Distinguished Lecture, AT&T Research, Middletown, NJ, August 2010
- IEEE Distinguished Lecture, DRS Technologies, Gaithersburg, MD, August 2010
- IEEE Distinguished Lecture, IEEE Communications Society Chapter, Baltimore, MD, August 2010
- Keynote, INFORMS Telecom, Montreal, Canada, May 2010
- Panel, OFC Conference, San Diego, CA, March 2010
- Keynote, Euro-NGI Conference, Aveiro, Portugal, July 2009
- Distinguished Lecture, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile, November 2008
- Distinguished Presentation, IEEE ICCCN Conference, Saint Thomas, August 2008
- Keynote, 5th Workshop on Optimization of Optical Networks, Montreal, Canada, May 2008
- Panel, ONDM Conference, Vilanova i la Geltru, Spain, March 2008
- Panel, BROADNETS conference, San Jose, CA, October 2006
- Distinguished Lecture, University of Evry, France, July 2006
- Panel, UNC Teaching and Learning with Technology (TLT) conference, Chapel Hill, NC, March 2006
- Distinguished Lecture, Carleton University, Canada, December 2005
- Distiguished Lecture, National Technical University of Athens, Greece, June 2004
- Distiguished Lecture, Athens Institute of Technology, Greece, June 2004
- Distiguished Lecture, University of Patras, Greece, May 2004

Funded Research Proposals and Grants

CNS Core:Small:On Parallelizing Optical Network Design Problems:Towards Network Optimization as a Service (PI: Rouskas)
National Science Foundation
Amount: \$440,000, October 2019-September 2022

Graduate Industrial Traineeships (PI: Rouskas)
SAS, Genworth, RENCI
Amount: \$460,000, June 2014-May 2020

Cisco Internship Program (PIs: Rouskas, Ning)
Cisco
Amount: \$160,000, May 2011-December 2012

NeTS: Large: Collaborative Research: ChoiceNet: Network Innovation Through Choice (NC State PIs: Rouskas, Dutta)
National Science Foundation
Amount: \$643,917 (total budget: \$2.732M), September 2011-December 2015

NeTS: Small: Computationally Scalable Aware Optical Network design (PI: Rouskas)
National Science Foundation
Amount: \$430,000, August 2011-July 2016

SURFnet GigaPort3 Research Plan (PIs: Rouskas, Karmous-Edwards)
SURFnet
Amount: \$280,000, July 2009-May 2012

GENI IMF: Integrated Measurement Framework and Tools for Cross Layer Experimentation (PIs: Dutta, Rouskas)
GENI Program Office
Amount: \$420,000, October 2009-September 2012

Edge Reconfigurable Optical Networks (ERONs) for High-Performance Applications (PIs: Rouskas, Reeves)
DARPA
Amount: \$250,000, July 2008- December 2009

CPATH-CB: Computing Across Curricula
National Science Foundation
Amount: \$275,000, July 2007-June 2010

An Intelligent Second-Life VCL-Based Computing Lab (PIs: Rouskas, Young)
IBM Faculty Award
\$30,000, July 2007

Lambda Scheduling for Grid Applications
NC State Center for Advanced Computing and Communication (CACC)
Amount: \$40,000, July 2007-June 2008

Learning with In-class Technology (LIT): The 15-Minute Learning Module Approach
NC State LITRE
Amount: \$8,000, June 2006-May 2007

Collaborative Research: NeTS-FIND: The SILO Architecture for Services Integration, controL, and Optimization for the Future Internet (PIs: Rouskas, Dutta)
National Science Foundation
Amount: \$228,000 (total budget: \$408,000), September 2006-May 2010

Integration of Network Survivability Concepts in an MS in Computer Networking Curriculum (PIs: Dutta, Rouskas)
Microsoft Trustworthy Computing Curriculum
Amount: \$50,000, January 2006-December 2006

Traffic Quantization: A Formal Approach To Scalability in Packet-Switched Networks
National Science Foundation
Amount: \$357,000, September 2004-August 2009

A Formal Approach to Traffic Grooming in Optical Networks with General Topologies (PIs: Rouskas, Dutta)
National Science Foundation
Amount: \$405,000, September 2003-August 2006

Transparent Optical Network Management and Routing with Just In Time Signaling (PIs: Rouskas, Perros)
NSA LTS
Amount: \$327,000 (total budget: \$1,350,000), January 2003-December 2004

Optical Network Lab Equipment
MCNC-RDI
Amount: \$640,000 (six Optera WDM switches with SONET and Gigabit Ethernet interfaces), August 2003

Engineering Online Student Access to Internet Lab
NC State DELTA
Amount: \$10,000, January 2003-June 2003

Access Protocols for Multicasting in an Optical Burst Switching Metro Ring (PIs: Perros, Rouskas)
Alcatel
Amount: \$45,000, January 2002-September 2003

Performance Analysis and Alternate Routing for Just In Time Optical Burst Switching Networks (PIs: Rouskas, Perros, Franzon)
NSA LTS
Amount: \$437,000 (total budget: \$1,500,000), January 2002-June 2003

Performance Evaluation of IPv6 Tunneling
IBM Faculty Award (PIs: Devetsikiotis, Rouskas)
Amount: \$40,000, July 2001

Research in Optical Burst Switching (PIs: Perros, Rouskas)
NC State Center for Advanced Computing and Communications (CACC)
Amount: \$43,000, July 2001-June 2002

Multicast Support for Just In Time Optical Burst Switching Networks (PIs: Rouskas, Perros)
NSA LTS
Amount: \$70,000 (total budget: \$500,000), October 2000-March 2001

Project: Optical Burst-Switched Ring Networks (PIs: Perros, Rouskas)
NC State Center for Advanced Computing and Communications (CACC)
Amount: \$35,000, July 2000-June 2001

Regional Testbed Optical Access Network for IP, Multicast, and Differentiated Services
DARPA Next Generation Internet (NGI) Program
Amount: \$214,000 (total budget: \$1,800,000), March 2000-March 2002

Networking Lab Equipment

HP U.S. University Equipment Grants

Amount: \$159,190 (50 HP Kayak workstations and 3 laser printers), December 1999

Internet Teaching Lab

CAIDA Internet Teaching Laboratories (ITL) Initiative

Amount: \$100,000 (4 Cisco Routers)i, October 1999

Performance Analysis of Wavelength Routed Wide Area Networks (PIs: Rouskas, Perros)

National Science Foundation

Amount: \$255,000, September 1998-August 2002

MTCP: TCP-like Congestion Control for Reliable Multicast (PIs: Rhee, Rouskas)

NC State Center for Advanced Computing and Communications (CACC)

Amount: \$78,000, July 1998-June 2000

Towards an All-Optical Network Infrastructure: Interconnection of Photonic WDM Broadcast-and-Select Local Area Networks

National Science Foundation (CAREER)

Amount: \$200,000, September 1997-August 2002

All-Optical Solutions to ATM Switching

NC State Center for Advanced Computing and Communications (CACC)

Amount: \$40,000, July 1995-June 1996

Multicasting for Multimedia Applications

NC State Faculty Development and Research Support

Amount: \$5,000, January 1995-June 1995

III. Leadership and Service

Society Memberships

FELLOW, Institute of Electrical and Electronics Engineers, Communications Society

MEMBER, Association for Computing Machinery, also Special Interest Group on Computer Communications

IEEE Leadership

CHAIR, IEEE Communications Society Distinguished Lecturer Selection Committee, 2016-2017

VICE CHAIR, IEEE Communications Society Technical and Educational Activities Council, 2016-2017

VICE CHAIR, IEEE Communications Society TCs Recertification Committee, 2016-2017

CHAIR, IEEE Communications Society Optical Networking Technical Committee (ONTC), 2016-2017

VICE CHAIR, IEEE Communications Society Optical Networking Technical Committee (ONTC), 2014-2015

SECRETARY, IEEE Communications Society Optical Networking Technical Committee (ONTC), 2012-2013

Technical Journal Leadership

FOUNDING EDITOR-IN-CHIEF, *IEEE Networking Letters*, 2018-2021

FOUNDING EDITOR-IN-CHIEF, *Optical Switching and Networking*, Elsevier, 2004-2017

Conference Committee Leadership

MEMBER, STEERING COMMITTEE, *OFC Conference*, 2018-present

CHAIR, STEERING COMMITTEE, *IEEE LANMAN*, 2015-2018

EXECUTIVE CHAIR, *ICCCN 2022*, Honolulu, Hawaii, July 25-28, 2022.

TPC CO-CHAIR, *DRCN 2022*, Vilanova, Spain, March 28-31, 2022.

TPC CO-CHAIR, *IEEE MeditCom 2021*, Athens, Greece, September 7-10, 2021.

GENERAL CHAIR, *ICCCN 2021*, Athens, Greece (virtual conference), July 19-22, 2021.

GENERAL CO-CHAIR, *IEEE MASS 2018*, Chengdu, China, October 9-12, 2018.

PROGRAM CO-CHAIR, *IEEE ICC 2017, Optical Networks and Systems (ONS) Symposium*, Paris, France, May 21-25, 2017.

GENERAL CO-CHAIR, *IEEE ICNP 2014*, Raleigh, NC, October 21-24, 2014.

GENERAL CHAIR, *ICCCN 2013*, Nassau, Bahamas, July 30-August 2, 2013.

PROGRAM CO-CHAIR, *ICCCN 2011*, Maui, Hawaii, August 1-4, 2011.

PROGRAM CO-CHAIR, *IEEE Globecom 2010, Optical Networks and Systems (ONS) Symposium*, Miami, FL, November 28-December 3, 2010.

PROGRAM CO-CHAIR, *ICCCN 2009, Internet Services, Systems and Applications (ISSA) Track*, San Francisco, CA, August 2-6, 2009.

GENERAL CO-CHAIR, *International Conference on Broadband Communications, Networks, and Systems (BROADNETS 2007)*, Raleigh, NC, September 10-13, 2007

GENERAL CO-CHAIR, *14th IEEE Workshop on Local and Metropolitan Area Networks (LANMAN 2005)*, Chania, Crete, Greece, September 18-21, 2005.

PROGRAM CO-CHAIR, *Workshop on Traffic Grooming (WTG 2004)*, October 29, 2004, San Jose, CA

TECHNICAL PROGRAM CHAIR, *13th IEEE Workshop on Local and Metropolitan Area Networks (LANMAN 2004)*, April 25-28, 2004, San Francisco, CA

TECHNICAL PROGRAM CO-CHAIR, *IFIP Networking 2004*, May 9-14, 2004, Athens, Greece

Editorial and Review Work for Technical Journals and Publishers

ASSOCIATE EDITOR, *IEEE/OSA Journal of Communications and Networking*, 2010-2012

CO-GUEST EDITOR, *JCM Journal of Communications*, Special Issue on the “Advances in Communications and Networking,” vol. 6, no. 9, December 2011.

ASSOCIATE EDITOR, *IEEE/ACM Transactions on Networking*, 2000-2004

ASSOCIATE EDITOR, *Computer Networks*, 2001-2004

ASSOCIATE EDITOR, *Optical Networks*, 2000-2004

CO-GUEST EDITOR, *IEEE Journal on Selected Areas in Communications*, Special Issue on “Protocols for Next Generation Optical WDM Networks,” vol. 18, no. 10, October 2000.

REVIEWER, Morgan Kaufmann, John Wiley and Sons, Cambridge University Press, Springer, IEEE Transactions on Networking, IEEE Transactions on Computers, IEEE Transactions on Communications, IEEE/OSA Journal of Lightwave Technology, IEEE/OSA Journal of Optical Communications and Networking, IEEE Journal on Selected Areas in Communications, Computer Networks Journal, International Journal of Performance Evaluation, European Transactions on Telecommunications, Photonic Network Communications Journal, IEEE Computer Magazine, IEEE Communications Magazine, IEEE Network Magazine, and numerous conferences

PROPOSAL REVIEW PANELIST, National Science Foundation – on numerous occasions

Conference Program Committees

IEEE GLOBECOM: 2003-2023

IEEE ICC: 2003-2023

IEEE LANMAN: 2007-2023

IEEE INFOCOM: 2007-2013, 2004, 1996-1998

ONDM: 2014-2023, 2009, 2005

IFIP NETWORKING: 2023, 2019, 2005-2012
OSA NETWORKS: 2017-2019
OFC/NFOEC: 2008-2010
Euro NGI: 2008-2011
EuCNC: 2015-2017
ACM CoNEXT Cloud Assisted Networking: 2016-2017
TEMU: 2012-2016
Networks: 2008-2016
DRCN: 2019-2021, 2015, 2011
NOC: 2014-2015
IEEE NFV-SDN: 2015
ITC: 2013
IEEE ICNP: 2013, 2008, 1997
ICCCN: 2012, 2006
ICNC: 2020, 2012
IEEE ANTS: 2011, 2009, 2008
RNDM: 2010-2011
ACP: 2010
ReArch Workshop: 2009-2010
INFORMS Telecom: 2010
WOBS: 2009, 2003-2005
BROADNETS: 2004-2006
IEEE HPSR Workshop: 2019, 2003-2005
OPTiCOMM: 2000-2003
SPIE Conference on All-Optical Networking: 1998-1999

NC State: University Committees

MEMBER, Administrative Board of the Graduate School (ABGS), 2016-2018
 JUDGE, Graduate Student Research Symposium, 2018, 2014
 MEMBER, Microsoft Research Faculty Fellowship Review Committee, 2012-2013
 MEMBER, DELTA IDEA grant review committee, 2004-2005
 MEMBER, DELTA Advisory Committee, 2003-2005
 CHAIR, DELTA Subcommittee on Intellectual Property, 2003-2005
 MEMBER, Alumni Outstanding Research Awards Selection Committee, 2004

NC State: College of Engineering Committees

MEMBER, University Faculty Scholar Selection Committee, 2012-2014

MEMBER, ALCOA Awards Committee, 2012-2013

MEMBER, College Reappointment, Promotion, and Tenure (RPT) Committee, 2008-2011

textscMember, College Research Committee, 2007-2008

MEMBER, CSC Head Search Committee, 2004-2006

MEMBER, Engineering Online Advisory Committee, 2003-2005

MEMBER, CSC Review Survey Committee, 1998-1999

MEMBER, Admissions Standards Committee, MS in Computer Networking, 1998-1999

NC State: Department of Computer Science Committees

CHAIR, Networking faculty search committee, 2021-2022

MEMBER, Reappointment, Promotion, and Tenure (RPT) Committee, 2017-present

CHAIR, Strategic Planning Committee, 2009-2012

MEMBER, Graduate Student Admissions Committee, 2011-2012

MEMBER, Awards Committee, 2009-2012

MEMBER, Faculty Recruiting Committee, 2008-2009

COURSE COORDINATOR, CSC 316 (Data Structures), 2005-2017

MEMBER, Computing Infrastructure Committee, 2006-2010

CHAIR, Minority Recruiting Committee, 2006-2007

MEMBER, Committee for External Evaluation Visit, Fall 2004

MEMBER, Strategic Planning Committee, 2003-2004

MEMBER, Research Productivity Committee, 2003-2004

MEMBER, Strategic Planning Committee, 2002-2005

CHAIR, Faculty Recruiting Committee, 2001-2002

CHAIR, Faculty Recruiting Committee, 2000-2001

PEER EVALUATOR, 23 teaching evaluations, 1999-present

MEMBER, Graduate Student Admissions Committee, 1996-1998

MEMBER, PhD Qualifying Exam Committee, 1994-1996

NC State: Operations Research and ECE Committees

MEMBER, OR Graduate Student Admissions Committee, 2012-2013, 2005-2007

MEMBER, ECE Faculty Recruiting Committee, 1999-2000

Other National and International Activities

MEMBER, International Advisory Committee, Scuola Superiore Sant'Anna, Pisa, Italy, 2013-2014

MEMBER, Committee of Visitors (CoV), DoE Networking Research Program, 2011

MEMBER, Best Paper Award Committees

IEEE ICC, 2021

IEEE/OSA Journal of Optical Communications and Networking, Charles Kao Award, 2015-2017

IEEE ICC, 2016

ICNC, 2015

ACP, 2012, 2009

IEEE INFOCOM, 2011

IEEE ANTS, 2010

IEEE FELLOW NOMINATOR, four cases, 2018-present

IEEE FELLOW REFERENCE, 19 cases, 2012-present

EXTERNAL REVIEWER for the promotion to Full Professor, 26 cases, 2004-present

EXTERNAL REVIEWER for the promotion to Associate Professor with tenure, 29 cases, 2000-present

IV. Technical Expert Experience

MPH Technologies OY v. Apple Inc., United States District Court for the Northern District of California, Civil Action No. 3:18-cv-05935.

Involved in all aspects of litigation including development of infringement charts for a wide range of products, prior art and invalidity analysis for a number of products, claim construction, deposition of opposing experts, source code inspection and analysis, and infringement under the doctrine of equivalents. Ongoing.

Epic v. IngenioShare, IPR2022-00202, IPR2022-000291, IPR2022-000294, IPR2022-000295.

Evaluated a family of patents relating to portal-based Internet communications, analyzed prior art and petitioner's arguments, prepared expert declarations, assisted with the patent owner (IngenioShare) reply, provided deposition testimony (over two days), and assisted with oral argument preparations. IngenioShare won all four IPRs. Infringement case ongoing.

Microsoft/Apple v. Zipit, IPR2021-01129, IPR2021-01130, IPR2021-01131.

Evaluated a family of patents relating to instant messaging, analyzed prior art and petitioner's arguments, prepared expert declarations, assisted with the patent owner (Zipit) reply and sur-reply, provided deposition testimony, and assisted with oral argument preparations. Settled with Microsoft. Infringement case against Apple ongoing.

Huawei Technologies v. Verizon, IPR2021-00616, IPR-2021-00616.

Evaluated one family of patents relating to optical transport network (OTN) technologies and prepared expert declarations on behalf of plaintiff Huawei Technologies. Settled.

Verizon v. Huawei Technologies, IPR2020-01292, IPR-2020-1291, IPR2020-01290, IPR2020-01278.

Evaluated two families of patents relating to optical transport network (OTN) technologies, prepared expert declarations, and assisted with the patent owner (Huawei Technologies) reply. Institution of IPR denied.

Apple Inc v. MPH Technologies OY, IPR2019-00819, IPR2019-00820, IPR2019-00821, IPR2019-00823, IPR2019-00824, IPR2019-00826.

Evaluated two families of patents relating to secure messaging, VPN, and secure mobility protocols, prepared expert declarations, assisted with the patent owner(MPH) reply, sur-reply, and oral arguments, and provided deposition testimony (twice). MPH won all six IPRs.

Mears Technologies, Inc. v. Verizon Services Corporation, United States District Court for the Eastern District of Texas, Civil Action No. 2:14-cv-00937.

Mears Technologies, Inc. v. AT&T Corporation, United States District Court for the Eastern District of Texas, Civil Action No. 2:14-cv-00938.

Mears Technologies, Inc. v. Finisar Corporation, United States District Court for the Eastern District of Texas, Civil Action No. 2:13-cv-00376.

Evaluated one patent (relating to optical switching), developed infringement charts, carried out prior art and invalidity analysis and claim construction, prepared expert declarations, and provided deposition testimony on behalf of plaintiff Mears Technologies. Also developed infringement charts for products by several other companies.

Brixham Solutions LTD v. Juniper Networks, Inc., United States District Court for the Northern District of California, Civil Action No. 3:13-cv-00616-JCS.

Evaluated a portfolio of more than ten patents (relating to pseudowires, Ethernet services, protection and restoration, routing and switching), developed infringement charts, carried out prior art and invalidity analysis and claim construction, prepared expert declarations, and provided deposition testimony on behalf of plaintiff Brixham Solutions LTD.

Alberta Communications Research Centre v. AT&T Services Corp., United States District Court, District of New Jersey, Civil Action No. 3:09-03883

Alberta Telecommunications Research Centre v. Verizon Communications, Inc., United States District Court, District of New Jersey, Civil Action No. 3:10-01132

Verizon Services Corp. v. Alberta Telecommunications Research Centre, United States District Court, District of New Jersey, Civil Action No. 3:11-01378

Telecommunications Research Laboratories, et al. v. Qwest Communications Company, LLC, et al., United States District Court, District of New Jersey, Civil Action No. 1:12-00581

Evaluated of a portfolio of eighteen patents in the optical networking field (including SONET ring networks, protection switching, and virtual connections), participated in mediation proceedings, developed infringement charts for a wide range of products, carried out prior art and invalidity analysis and claim

construction, prepared expert declarations, and provided deposition testimony (three times) on behalf of plaintiff Alberta Communications Research Centre.